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Studies in the Genus Bidens. VIII. Contributions from the Hull Botanical Laboratory 375 - - - - - - - Earl Edward Sherff 1

A Morphological Comparison of Leaflets of a Hybrid Cycad and the Two Parents. Contributions from the Hull Botanical Laboratory 376 Sophia Papadopoulos 30

Some Misunderstood Piperaceae - - - - Lisle W. McKown 46

Aspects of the Madeira Flora - - - - - T. D. A. Cockerell 66

Notes on the Structure of Pennsylvanian Plants from Illinois. II J. H. Hoskins 74

Northern Aspect and Phenology of Tallahassee Red Hills Flora Herman Kurz 83

Some New and Little Known Species of Trachelomones from North Manchuria, China - - - - - - - B. W. Skvortzow 90

Vascularization of the Node in Zea mays - - Arthur T. Evans 97

Cleistogamy in Two Species of Danthonia - - Paul Weatherwax 104

Studies in the Genus Mentha - - - - Samuel M. Gordon 110

Current Literature

Book Reviews - - - - - - - - - - - - 116

Notes for Students - - - - - - - - - - - 117

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THE BOTANICAL GAZETTE

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THE

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March 1928

STUDIES IN THE GENUS BIDENS. VIII

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 375

EARL EDWARD SHERFF

(WITH PLATES I–V)

BIDENS PILOSA var. ALAUSENSIS (H.B.K.) Sherff (BOT. GAZ. 81:35. 1926) and certain related material.—

In a former article (BOT. GAZ. 76:158. 1923), *Bidens chilensis* var. *apiifolia* DC. was discussed and the Berlin cotype (*Poeppig* 207) of that variety was treated as "an unimportant foliage form of *B. alausensis*," later reduced by me to *B. pilosa* var. *alausensis*. Subsequent study of much cotype material, in conjunction with several specimens collected for me by *J. Francis McBride* at Matucana, Peru, revealed closer affinities of several of the original specimens with *B. pilosa* var. *radiata* Schz. Bip. Specimens of *Poeppig* 207 were studied in collections belonging to several of the older herbaria (Hb. Univ. Halle; Hb. DC. in Hb. Deless.; Hb. Mus. Vienna; Hb. Univ. Kiel; Hb. Berl., etc.). Two specimens in Vienna and one in Berlin appeared closer to var. *alausensis*, but the cotypes elsewhere appeared, when studied in the light of the interesting *McBride* specimens previously described by me (*cf.* BOT. GAZ. 81:35. 1926), to be closer to var. *radiata*.

The nomenclatural problem offered by the publication in 1836, by DE CANDOLLE, of this var. *apiifolia* is particularly vexing, since its publication antedated that for both the var. *alausensis* and the var. *radiata*. An equation of the var. *apiifolia* with either of these two varieties would compel, therefore, the taking up of the name *apiifolia* and the reduction of a well established name to synonymy. The intermediate nature and ill defined status of the variety *apiifolia* would make such a course seem unwise, if not indeed impossible (*cf.* Internat. Rules Bot. Nomencl. Art. 51, no. 4. 1906). Apparently the interests of taxonomy are best conserved by employing the new combination *B. pilosa* var. apiifolia (DC.), to apply only to the form intermediate between

vars. *alausensis* and *radiata*, and represented by *Poeppig* 207. In this case, the last two names, each certain in its application and well supported in herbaria by illustrative material, are left undisturbed.[1]

BIDENS ANDICOLA var. **cosmantha** (Griseb.) comb. nov.; *B. cosmantha* Griseb., Goett. Abhandl. **19**:137. 1874.—

GRISEBACH'S type of *B. andicola* var. *cosmantha* was *P. G. Lorentz* 1526, La Cienaga, Sierra de Tucuman, Argentina, March 25–31, 1872 (Hb. Berl.). Identical material was collected by *Lorentz* under nos. 540 and 540*b* (Granadillas near Yacatula, Province of Catamarca, Argentina, beginning of February, 1872; Hb. Berl.). These Lorentzian specimens are connected with *B. andicola* H.B.K. by too many intermediate forms to permit their being regarded as specifically distinct. They may best be regarded as a variety of *B. andicola*, more or less distinguished from the species proper by the tall slender habit, by the leaves more dissected (but less so than in var. *decomposita* O. Ktze.), and with outlines suggesting those of celery (*Apium graveolens* L.), also by the larger flowering heads, which when fully expanded reach a diameter of 6–7 cm.

BIDENS ANDICOLA H.B.K. Nov. Gen. et Sp. **4**:186 (237). 1820; *B. cosmantha* var. *diversifolia* Griseb. Symbol. Argent. 198. 1879.—

GRISEBACH'S *B. cosmantha* var. *diversifolia* was described as having the lowermost leaves ternatisect, the others entire, elliptic-oblong, sharply serrate. It came from the Province of Catamarca, Argentina. The Catamarca plants studied by GRISEBACH had been collected by *F. Schickendantz* (Griseb. *loc. cit.* 3). A good specimen of *F. Schickendantz* 200, from Catamarca and bearing the determination *B. cosmantha* var. *diversifolia* Griseb., is extant in the Berlin Herbarium. It is merely a specimen of *B. andicola* H.B.K.

BIDENS ASYMMETRICA (Lévl.) Sherff, BOT. GAZ. **81**:49. 1926; *B. gracilis* Nutt., Trans. Amer. Phil. Soc. Ser. II. **7**:368. 1841; Sherff, *loc. cit.* **70**:105 and Pl. XIII. 1920; *non B. gracilis* Torr., Ann. Lyc. N.Y. **2**:215. 1828; *Campylotheca gracilis* (Nutt.) Walp. Repert. Bot. Syst. **2**:618. 1843; *Lipochaeta asymetrica* Lévl., Fedde Repert. Sp. Nov. **10**:122. 1912 (PL. III).—

Excellent specimens of the type number (*Abbé Urbain Faurie* 960) of *B. asymmetrica* are preserved in herbaria (Hb. Par.; Hb. Deless.; Hb. Brit. Mus.). From a study of these specimens, it is evident that *B. asymmetrica* is specifically the same as *B. gracilis* Nutt., being merely a coarser and more herbaceous form of that species.

[1] Concerning the intermediate nature of var. *apiifolia*, it may be remarked that while DE CANDOLLE ranked this variety under *B. chilensis* DC. (=*B. pilosa* var. *alausensis*), *Poeppig's* original printed labels bore the name *B. leucantha* L. (=*B. pilosa* var. *radiata*).

Recently Professor OTTO DEGENER, of the University of Hawaii, has very kindly written me that *Bidens gracilis* Nutt. should be dropped, in view of the earlier [but invalid] name *B. gracilis* Torr. DEGENER proposed a new name. Since, moreover, it is likely that the International Rules of Nomenclature will ere long be amended in such manner as to compel (as does the American Code now) the retirement of such names as *B. gracilis* Nutt., DEGENER'S proposal would seem at first a good one. In our present case, however, the synonym *B. asymmetrica* is next in line for adoption, and precludes the necessity of using a new binomial as proposed by him.

Bidens degeneri nom. nov.; *Campylotheca dichotoma* Hillebr. Fl. Hawaiian Isls. 212. 1888; *Bidens dichotoma* (Hillebr.) Sherff, BOT. GAZ. **70**:98. 1920; *non B. dichotoma* Desf. Tabl. Edit. I:108. 1804 (*nom. nud.*); *et* Cat. Pl. Hort. Reg. Par. Edit. III:185. 1829.—This species is here renamed to avoid the confusion consequent upon the existence of the earlier *Bidens dichotoma* Desf. In choosing the trivial name it is a pleasure to acknowledge the assistance received from Professor DEGENER, who has placed at my disposal several independent observations on the nomenclature of certain Hawaiian species, and has obtained valuable herbarium specimens for my studies.

BIDENS DEGENERI **apioides** var. nov.—E specie foliis plerumque 3—partitis, grosse serratis vel dentatis vel etiam lobatis, foliolo terminali interdum subtripartito differt.

Otto Degener and *Henry Wiebke* 2179—b, wind-swept ridge, north of Pohakea Gulch, near Wailuku, Maui, Hawaiian Isls., July 23, 1927 (Hb. Field Mus., type; Hb. Univ. Hawaii).

The type of *B. degeneri* was known to have been collected upon Maui (*cf.* Hillebrand Fl. Hawaiian Isles. 213. 1888) but whether from "above Maalaea or on Haleakala" was not known definitely. HILLEBRAND (*loc. cit.*) cited *Mann* and *Brigham* 450 from a mountain near Waikapu, of the same island. *Gaudichaud* had collected this species somewhere in the Hawaiian Islands during September and October, 1836 (Hb. Par.). It has since been collected upon Oahu (*C. N. Forbes* 1982 O, Waimano Ridge, October 27–30, 1914, Hb. Bishop Mus.), upon Molokai (*C. N. Forbes*, sea cliffs of Halawa Valley, August, 1912, Hb. Bishop Mus.), and again upon Maui (*Degener* and *Wiebke* 2179, arid, wind-swept ridge, north of Pohakea Gulch, near Wailuku, July 23, 1927, Hb. Field Mus.; Hb. Berl; Hb. Boiss; Hb. Univ. Hawaii; Hb. Kew).

Western Maui is connected with eastern Maui by a broad, sandy isthmus, Wailuku, which appears to be the real home of the species. Recently *Degener* and *Wiebke*, on finding many specimens of the species proper, their no. 2179, growing near Wailuku, observed several bizarre plants which may be designated 2179-b. Regarding these latter, Professor DEGENER (*in litt.*) states: "Plants

of this type are somewhat rare and grow intermingled with typical ones." The leaves have their leaflets deeply toothed or lobed and suggest in outline the leaves of common celery, *Apium graveolens* L., whence the varietal name selected by me, *apioides*.

Among the specimens collected by *Degener* and *Wiebke* is a series of plants from the Island of Maui, their number 2163. These, while appearing new, are too close to *B. campylotheca* Schz. Bip. to warrant being ranked as specifically distinct. Their principal leaves, however, are regularly 5-parted, while in the species proper the leaves of well developed plants are regularly 3-parted.[2] The flowering heads have about 8 long, linear ligules, and when fully expanded reach a diameter of 4 cm. In the species proper, the ligules are usually fewer, shorter and broader, and the flowering heads commonly measure about 2 cm. in diameter. Heretofore the species has been definitely known only from the Islands of Oahu, Lanai, and Hawaii. The new form from Maui appears best treated as a variety:

BIDENS CAMPYLOTHECA **pentamera** var. nov.—Folia principalia plerumque 5—partita, jugi inferioris foliolis lanceolatis, sessilibus vel vix petiolulatis, circ. 5–6.6 cm. longis et 1.4–2.9 cm. latis; capitulis pansis ad anthesin 3–4 cm. latis; floribus ligulatis circ. 8, ligulis linearibus. Achaenia torta, non nisi ad apicem setosa, exaristata vel rariter obsolete aristata, 1 vel 2 aristis minutis, glabris, etiam infra apicem positis et in achaeniorum margines decurrentibus.

Otto Degener and *Henry Wiebke* 2163, fog-swept medium forest in Koolau Gap, Haleakala Crater, Maui, Hawaiian Isls., August 11, 1927 (type and cotypes in Hb. Field Mus.; cotypes in Hb. Univ. Hawaii; Hb. Berl.; Hb. Brit. Mus.; Hb. Par.; Hb. Kew, etc.).

BIDENS CAMPYLOTHECA var. PENTAMERA f. **filicifolia** f. nov.—E varietate foliis 7–9—foliolatis, foliolis terminalibus et basalibus saepe irregulariter 2–5—partitis, aliis simplicibus differt.

[2] I have been fortunate in securing a good representation of *B. campylotheca* in herbarium specimens for study: *Otto Degener* and *Henry Wiebke* 3000, sunny, rocky slope, Punaluu Valley, Isl. Oahu, Feb. 20, 1927 (Hb. Field Mus.; Hb. Univ. Haw.), *C. N. Forbes* 195H, Hanehane, Kona, Isl. Hawaii, June 17, 1911 (Hb. Bishop Mus.), *idem* 346H, Honomalino, Kona, Isl. Hawaii, July 25, 1911 (Hb. Bishop Mus.); *Gaudichaud* (Voyage of the Bonite) 220 *pro parte* and 221 *pro parte*, Hawaiian Isls., September-October, 1836 (Hb. Par.); *idem*, Hawaiian Isls., October, 1836 (Hb. Deless.); *Dr. W. Hillebrand* 39, Isl. Hawaii (Hb. Brit. Mus.; Hb. Kew); *Macrae*, Isl. Oahu, May, 1825 (Hb. Kew); *idem*, at Mt. Kaah, Isl. Oahu, June, 1825 (Hb. Deless.; Hb. Kew); *G. C. Munro* 464, Kaiholena, Isl. Lanai, Aug. 16, 1915 (Hb. Bishop Mus.); *idem* 505; Kohinahuia, Isl. Lanai, Feb. 12, 1916 (Hb. Bishop Mus., 3 sheets); *J. Remy* 285, Isl. Hawaii, 1851–1855 (Hb. Paris).

Otto Degener and *Henry Wiebke* 2177 *pro parte*, Koolau Gap, Haleakala Crater, Maui, Hawaiian Isls., August 11, 1927 (type and cotypes in Hb. Field Mus., cotypes in Hb. Univ. Hawaii).

One specimen of *Degener* and *Wiebke* 2177 is typical for the var. *pentamera*, but the remaining ones differ conspicuously in having 7–9 leaflets, the terminal one and the two of the basal pair often irregularly 2–5 parted. In view of the pronounced endemism among the Hawaiian plants, it seems wise to interpret this distinction as connoting a definite *forma* of *B. campylotheca* var. *pentamera*.

Bidens ctenophylla sp. nov.—Frutex ramosus ramis rubescentibus subtetrangularibus et vix glaucescentibus, glabratis, verisimiliter 5–10 dm. altus. Folia petiolata petiolis tenuibus 2–5 cm. longis, petiolo adjecto 5–12 cm. longa, membranacea, plerumque simplicia, basim integram versus rotundata vel late cuneata, supra medium raro integra plerumque perspicue pectinato-dentata dentibus (in unico latere saepius 3–9) plerumque prorsum spectantibus, apice acuminata, circumambitu ovata vel rhomboideo-ovata, margine aegre ciliata, supra glabrata, infra saepe paucis setis sparsissime adpresso-hispida; rarius tripartita, foliolis lanceolatis, lateralibus minoribus. Capitula numerosa, in inflorescentia corymbiformi disposita, radiata, pansa ad anthesin 4–6 mm. alta et circ. 1.5–1.8 cm. lata; pedicellis et pedunculis minimis dense et insigniter albido-pubescentibus. Involucri bracteae dense hispidae, exteriores 5–8, lineares, patentes, apice acutae, 1.5–2.5 mm. longae; interiores lanceolatae, dimidio longiores. Flores ligulati plerumque 5, ligula late lineari-oblongi vel obovati, flavi, apice rotundato integri vel obscure denticulati, 7–10 mm. longi. Achaenia demum paleas anguste lineares paulo superantia, recta vel subrecta, sublate oblongo-linearia, valde obcompressa, corpore nigro 8–11 mm. longa et 1.5–2 mm. lata, faciebus marginibusque glabra, apice (saepe imperfecte) biaristata aristis usque ad 1.2 mm. longis in achaeniorum duos subalatos stramineos margines decurrentibus, retrorsum barbatis vel demum plus minusve calvis.

Otto Degener and *Henry Wiebke* 2128, arid, weed-covered "aa"[3] slopes, between Puuwaawaa and Huehue, Hawaii, Hawaiian Islands, August 22, 1926 (type and cotypes in Hb. Field Mus.; cotypes in Hb. Univ. Hawaii, Hb. Berl., Hb. Brit. Mus., Hb. Par., Hb. Kew., etc).

In foliage this species resembles more strongly the simple-leaved forms of *B. asymmetrica* (Lévl.) Sherff (*B. gracilis* Nutt.) than it does any other Hawaiian

[3] *Aa*, anglicized from the Hawaiian and meaning a loose, rough type of lava (*fide* O. Degener *in litt.*).

species of *Bidens*. The teeth are frequently so elongated as to give a comblike or pectinate edge to the leaves. The branching habit also is like that of *B. asymmetrica*. The capitula, however, are more numerous than in *B. asymmetrica*, and are borne on conspicuously white-pubescent branchlets. The achenes, furthermore, are distinct, being wider and noticeably broad-margined, the winglike margins continuing at the top into the aristae. In fact, the achenes suggest somewhat those of *B. macrocarpa* (Gray) Sherff.

Bidens hillebrandiana (Drake del Cast.) Deg. *in litt.*, comb. nov.; *Campylotheca remyi* Hillebr. Fl. Hawaii. Isls. 212. 1888; *Coreopsis hillebrandiana* Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 209. 1890; *Campylotheca rutifolia* Lévl., Fedde Repert. Spec. Nov. **10**:123. 1911; *Bidens remyi* (Hillebr.) Sherff, BOT. GAZ. **70**:97. 1920; *non B. remyi* Drake del Cast. *loc. cit.* 78, pl. 39. 1888; *ibid.* 210. 1890.—

Bidens remyi Dr. del Cast. was published at first (1888) only with a plate and analysis. The description followed later (1890). Even though this name (based upon *J. Remy* 281) is referable to *B. micrantha* Gaud. (*cf.* BOT. GAZ. **70**:97, footnote 9, 1920), it nevertheless may well be taken as having precluded the acceptance of my name *B. remyi* (Hillebr.), made later. DEGENER suggests (*in litt.*, Feb. 21, 1927) the taking up, therefore, of the trivial name *hillebrandiana* for the plant first described by HILLEBRAND under the name *Campylotheca remyi*.[4]

BIDENS SANDVICENSIS var. **setosa** comb. nov.; *B. setosa* Sherff, BOT. GAZ. **70**:103. 1920.—

The type material of *B. setosa* (*C. N. Forbes* 811K, Waimea Drainage Basin, West Side, Kauai, Hawaiian Isls., July 3–August 18, 1917) was a slightly monstrous or pathological form, as to vegetative parts, and did not match any known species. The singularly hairy achenes were very unique and were relied upon as indicating a distinct species. More recently, however, I found in the Delessert Herbarium a specimen from another collection (*Abbé Faurie* 961, Holokele, Hawaii, Hawaiian Isls., March, 1910). This lacked all traces of any pathological condition. Its floral and achenial characters matched those of the type precisely, but the foliage and growth habit were those of normal *B. sandvicensis* Less.[5] I have concluded that a varietal rank under *B. sandvicensis* is more nearly expressive of the true status of the *setosa* forms.

[4] I am informed very kindly by Dr. JOHN HENDLEY BARNHART, of the New York Botanical Garden (*in litt.*, Nov. 30, 1927), that HILLEBRAND'S Flora Hawaiiensis was mentioned in the Journal of Botany for April, 1888, and was published "probably in March" of that year. Dr. BARNHART finds DRAKE DEL CASTILLO'S work (Ill. Fl. Ins. Mar. Pacif., fasc. 4) referred to later, Nat. Novit., 2nd number for June, 1888; he believes that DRAKE DEL CASTILLO'S work (fasc. 4) was published "probably late in May" of the same year.

[5] The achenes were mostly exaristate or shortly aristate. A duplicate in the British Museum of Natural History, however, had the achenes mostly very distinctly biaristate with aristae retrorsely barbed and about 1 mm. long.

BIDENS SANDVICENSIS var. **caduca** nom. nov.; *Campylotheca sandwicensis* var. β, Hillebr. Fl. Hawaiian Isls. 214. 1888.—

HILLEBRAND (*loc. cit.*) described under *Campylotheca sandvicensis* (Less.) Hillebr. a var. β from the Island of Molokai. This variety, which is here given a more conventional name, is perhaps unrepresented in herbaria. It is of uncertain status. I do not recall having seen authentic material of it and must defer detailed treatment until some future time.

HILLEBRAND'S description, here Latinized, is essentially as follows: Folia superiora simplicia vel tripartita, laminis vel segmentis magis elongatis, dentibus minus protractis. Capitula minora et multo plura, inflorescentia corymbiformi sed vix exserta. Achaenia valde exalata, aristis filiformibus vix hamosis et mox caducis.

BIDENS MACROCARPA var. **ovatifolia** (Gray) comb. nov.; *B. sandvicensis* var. *ovatifolia* Gray, Proc. Amer. Acad. **5**:128. 1861; *Campylotheca* (*Coreopsis*) *macrocarpa* var. *ovatifolia* (Gray) Hillebr. *loc. cit.* 215.—

GRAY'S type (U.S. Nat. Hb.) was collected on the Island of Oahu, by the *United States Exploring Expedition under Captain Wilkes*. I have never seen another specimen exactly matching this type, but *C. N. Forbes* 2313 O, Kalihi, Isl. of Oahu, March 9, 1916 (Hb. Bishop Mus.) shows in its lowermost leaves an approach to the *ovatifolia* form. Both plants have capitula referable to *B. macrocarpa* rather than *B. sandvicensis*. In fact, Drake del Castillo (Illustr. Fl. Ins. Mar. Pacif. 209. 1890) equated the *ovatifolia* form outright with *B. macrocarpa* (*Coreopsis macrocarpa* Gray). The exceptional nature of the leaves, however, makes it seem best to retain a varietal status for Gray's type, as was done by HILLEBRAND.

BIDENS CAMPYLOTHECA var. **nematocera** nom. nov.; *Campylotheca grandiflora* var. β Hillebr. *loc. cit.* 215.—

HILLEBRAND retained the name *Campylotheca grandiflora* DC. for the species named *Bidens campylotheca* by Schultz Bipontinus (and also, though inadvertently, *Coreopsis macraei* by Gray). Under it he listed one variety, var. β, from the "N. coast of Molokai! and probably also of Maui." I have never found authentic material of this variety in herbaria. The description given by HILLEBRAND is essentially as Latinized herewith: Folia petiolata petiolis circ. 7.5 cm. longis, summa indivisa, cetera 3-partita (vel interdum 5-partita, foliolis jugi inferioris breviter petiolulatis, ovato-oblongis et ad basim cuneatis, vel rhomboideis, acute serratis, breviter cuspidatis, 7.6–8.9 cm. longis et 3.2–3.8 cm. latis). Panicula quam ea speciei brevior, cymis axillaribus magis ramosis et rursus paniculatis. Flores ligulati 5–8, ligula obovato-oblongi, 1.5–1.7 cm. longi. Flores disci 15–20. Achaenia angusta, torta, ciliata, biaristata aristis longis (4 mm.), filiformibus, deciduis, erecte retrorsumque dentata.

From the var. *pentamera* already described (*supra* p. 4), the var. *nematocera*

is seen to differ in having the petioles of the principal leaves 7.5 cm. long, not about 2–6 cm. long, the leaflets of the lower pair ovate-oblong with cuneate base, or rhomboideal, shortly petiolulate, 7.6–8.9 cm. long and 3.2–3.8 cm. wide, not lanceolate, not sessile or virtually so, not about 5–6.6 cm. long and 1.4–2.9 cm. wide; the ray florets obovate-oblong, not linear; the achenes ciliate and biaristate with filiform, deciduous awns 4 mm. long, these both upwardly and downwardly toothed [or barbed], not glabrous, nor glabrous except for a few minute bristles at the top, not with the bodies exaristate or sometimes having 1 or 2 minute, smooth awns arising from below the achenial apex and continuous with or decurrent into the achenial margins.

BIDENS MICRANTHA var. **laciniata** (Hillebr.) comb. nov.; *Campylotheca micrantha* var. *laciniata* Hillebr. *loc. cit.* 216.—

In his Flora of The Hawaiian Islands, HILLEBRAND listed two varieties under *Bidens micrantha* Gaud. (*Campylotheca micrantha* Cass). One of these was his var. *laciniata*, and for its habitat the Islands of Maui (Honuaula, Kula, Wailuku) and Hawaii were cited. Fortunately there still exists in the Herbarium of the Bernice Pauahi Bishop Museum (Honolulu) a specimen collected by *Hillebrand* and *Lydgate* at Kula, Isl. of Maui, and determined on the original label as "β var. *laciniata* Hbd." Still another original specimen is in the British Museum of Natural History. It was collected by *Hillebrand* alone, at Wailuku, and was labeled "*Campylotheca micrantha* β var." These plants are seen to come from HILLEBRAND'S cited localities and may be regarded as authentic for the var. *laciniata*. Aided by these specimens and HILLEBRAND'S description, I have assembled the following short list of representative specimens: *Abbé Faurie* 997, Wailuku, Maui, August, 1909 (Hb. Brit. Mus.); *C. N. Forbes* and *C. M. Cook, Jr.*, 24 M, Maunahooma, W. Maui, May, 1910 (Hb. Bishop Mus.; Hb. Field Mus.); *Dr. William Hillebrand*, south ridge of Valley of Wailuku, Maui, August, 1870 (Hb. Brit. Mus.); *idem* and *Rev. J. M. Lydgate*, Kula, Maui (Hb. Bishop Mus.); *J. Remy* 280, Maui, 1851–1855 (Hb. Gray).

BIDENS MICRANTHA var. **kaalana** nom. nov.; *Campylotheca micrantha* var. γ Hillebr. *loc. cit.*—

HILLEBRAND cited "Oahu! Kaala, and Waianae range" for his var. γ. In the apparent absence from herbaria of authentic original specimens, it had seemed unwise to attempt taking up this variety and giving it a conventional name. Several years ago, however, Professor C. N. FORBES sent me a large collection of Hawaiian specimens of *Bidens* which he had collected (*cf.* BOT. GAZ. **70**:98. 1920), and among these was one plant from the type locality cited by HILLEBRAND: Makaha Valley, Kaala Range, Oahu, February 12–19, 1909 (now in Hb. Field Mus.). This plant matches HILLEBRAND'S description very closely, and is so different from typical *B. micrantha* that it may well be interpreted as representing a valid variety.

BIDENS MENZIESII var. **leptodonta** nom. nov.; *Campylotheca* (*Coreopsis*) *menziesii* var. β Hillebr. *loc. cit.* 216.—

HILLEBRAND cited only the Island of Molokai for *B. menziesii* proper, but fairly typical material has been collected in the northern part of the Island of Maui (C. N. Forbes, August, 1910, Hb. Bishop Mus.; Hb. Field Mus.). HILLEBRAND recognized two varieties. His var. β, here named *leptodonta*, was cited for eastern Maui and also the Island of Hawaii. His description is faulty, giving the leaves as 2 inches long, the primary segments cut to the rhachis. The leaves on some of his own material are over 5 inches long; only comparatively few of the primary segments are cut to the rhachis, but usually enough are thus deeply cut to impart a distinctive foliage aspect. The following specimens of var. *leptodonta* have been examined:

C. N. Forbes 162 H, slopes of Hualalai, Isl. of Hawaii, June 15, 1911 (Hb. Bishop Mus.); *Dr. William Hillebrand* 29, Kohala, Isl. of Hawaii (Hb. Kew); *idem* 298, Isl. of Hawaii (Hb. Kew); *idem*, Isl. of Maui (*sub nom. Campylotheca menziesii* β var., Hb. Brit. Mus.); *Joseph F. Rock* 8310, alt. 6000 ft., Kemole, Mauna Kea, Isl. of Hawaii (Hb. Gray).

BIDENS MENZIESII var. **filiformis** nom. nov.; *Campylotheca menziesii* var. γ Hillebr. *loc. cit.* 216.—

This is the variety having the leaf-divisions very narrow and more or less filiform. The following specimens are typical:

C. N. Forbes 877 H, Koehe, Isl. of Hawaii, June 17, 1915 (Hb. Bishop Mus.; Hb. Field Mus.); *Dr. William Hillebrand* 30, Central Plateau, Isl. of Hawaii (Hb. Kew); *idem* and *Rev. J. M. Lydgate, cum specie commixt.*, Hawaiian Isls. (Hb. Bishop Mus.); *H. Mann* and *W. T. Brigham*, Central Plateau, Isl. of Hawaii (Hb. Bishop Mus.); *iidem* 520, alt. 6000 ft., Hualalai, Isl. of Hawaii (Hb. Bishop Mus.; Hb. Deless.; Hb. Kew; Hb. Missouri Bot. Gard.); *iidem* 589, Hawaiian Isls. (Hb. Bishop Mus.); *Joseph F. Rock* 8351, Nohonaohae crater, Isl. of Hawaii, June, 1910 (Hb. Gray).

BIDENS PAUPERCULA Sherff, BOT. GAZ. **76**:158. 1923; *B. ciliata* De Wild., Fedde Repert. Sp. Nov. **13**:203. 1914; *non B. ciliata* Hoffmgg. *ex* Fisch. *et* Mey. Ind. Sem. Hort. Petrop. **6**:46. 1839.—

This little known species was first collected by *J. Bequaert*, no. 302, Elisabethville, Katanga, Belgian Congo, April 4, 1912 (Hb. Bruss., 2 sheets). *Bequaert's* plants were the type material of *B. ciliata* De Wild. In the same year *Ad. Stolz* collected a number of excellent specimens of this species (no. 1442, forest at 900 m. alt., Kyimbila, Nyassaland, July 22, 1912; Hb. Berl.—2 sheets; Hb. Univ. Copenh.; Hb. Deless.; Hb. Mus. Vienna; Hb. Munich). In 1914, *Rev. F. A. Rogers* collected in the type locality for *B. ciliata* De Wild. more robust material (no. 10956, Elisabethville, Belgian Congo, May), a specimen

of which I was permitted in 1924, through the courtesy of DR. J. BURTT DAVY, to examine and photograph.

These plants are not to be confused with *B. ciliata* Hoffmgg., which is represented by good material still extant (Hb. Mus. Vienna) and is found to be normal *B. pilosa* L.

BIDENS PILOSA L. Sp. Pl. 832. 1753; *B. adhaerescens* Vell. Fl. Flum. 348, **8**:t. 88. 1827 (*pro parte*).

A careful study of VELLOZO's description and illustration of his *B. adhaerescens* shows that plant to be none other than *B. pilosa* L. His description of the capitulum, however, is not above criticism. In the short, abridged description at the beginning, we read: "floribus terminalibus, discoideis." This would limit the description, of course, to *B. pilosa* proper. In the detailed description which follows, however, we read: "Corollula composita, quandoque radiata, radis octo ligulatis, albis." Thus it is seen that he really included also the plants with white rays, forms which today are separately treated as *B. pilosa* var. *radiata* Schz. Bip.[6]

BIDENS MICRANTHOIDES Sherff, BOT. GAZ. **70**:100. 1920; *B. angustifolia* Nutt., Trans. Amer. Phil. Soc. Ser. II. **7**:369. 1841; *Campylotheca angustifolia* (Nutt.) Walp. Repert. **2**:618. 1843; *non Bidens angustifolia* Lam. Encycl. **1**:416. 1783.—

The type of *B. angustifolia* Nutt., collected by *Thomas Nuttall* himself on the Island of Oahu, Hawaiian Islands, is still preserved (Hb. Brit. Mus.). It is found to be identical with the type and other cited specimens of *B. micranthoides* Sherff, but the name *angustifolia* is here rejected because of the existence of the earlier homonym *B. angustifolia* Lam.[7]

BIDENS CHINENSIS (L.) Willd. Sp. Pl. 3. 1719 (*quoad synonyma et herb. Willd. n.* 15023, *fol. 4*). 1804; *B. robertianifolia* Lévl. *et* Vant. *ex* Lévl., Fedde Repert. Nov. Sp. **8**:140. 1910.—

LÉVEILLÉ cited as the type for *B. robertianifolia* Lévl. and Vant., a plant collected in Corea by *Taquet:* Island of Quelpaert, in uncultivated places at Hongno, Sept. 23, 1908. There exists a fine specimen with these data in Geneva (*Taquet* 969, Hb. Deless.). It is *B. chinensis* (L.) Willd.

Bidens bipontina nom. nov.; *B. serrulata* Schz. Bip., Flora **39**: 361. 1856; *non* Desf. Cat. Hort. Par. Edit. II:130. 1815; *Coreopsis serrulata* (Schz. Bip.) Benth. and Hook. *ex* Drake del Cast. Illustr.

[6] For an extended discussion of VELLOZO and his work, see HOOK. Jour. Bot. 4:4. 1842.

[7] A name referred by LAMARK himself (*loc. cit.*) and by A. H. MOORE (Proc. Amer. Acad. **42**:528. 1907) to *Spilanthes urens* Jacq.

Fl. Ins. Mar. Pacif. 210. 1890 (*cf.* Fl. Polyn. Fr. 109. 1893); *non* Poir. Encycl. Supplem. **2**:352. 1811.—

This species, inadequately described by SCHULTZ BIPONTINUS from a fragmentary specimen, *Ed. Jardin* 132, from the Island of Nukahiva (Marquis Isls.), may here be renamed to avoid confusion with *B. serrulata* Desf.

BIDENS SERRULATA (Poir.) Desf. Tabl. Ecol. Bot. Edit. II:130. 1815; Cat. Hort. Par. Edit. III:186. 1829; *Coreopsis serrulata* Poir. Encycl. Supplem. **2**:352. 1811; *Bidens grandiflora* Balb. Cat. Hort. Taur. 19. 1812; *B. grandiflora* Pers. *ex* Balb. *loc. cit.* 18. 1813; *Coreopsis diversifolia* Jacq. Eclog. Pl. **1**:80, tab. 54. 1811–1816; *Bidens quinqueradiata* Zea *fide* Jacq. *loc. cit.; Cosmea lutea* Sims, Curtis's Bot. Mag. **41**: pl. 1689. 1815; *Kerneria serrulata* (Poir.) Cass., Dict. Sci. Nat. **51**:474. 1827; *Bidens diversifolia* Hort. *ex* DC. Prodr. **5**:602. 1836; *non* Willd. *ex* DC. *loc. cit.; B. serratulata* Desf. *ex* DC. *loc. cit.; B. grandiflora* var. *diversifolia* (Jacq.) O. Ktze. Rev. Gen. **3**[II]:136. 1898; *B. grandiflora* var. *serrulata* (Poir.) O. Ktze. *loc. cit. ex synon. sed excl. plantam Boliviae.*[8]—

In my herbarium determinations of this species thus far I have employed the widely accepted name *B. grandiflora* Balb., a name going back to 1812. The trivial name *serrulata* was employed by POIRET one year earlier, however, and must be taken up. Certain authentic specimens of POIRET's species are still extant at Paris, where at least for several years this plant was cultivated. One of them ("Du Jardin des Plantes de Paris. 5 Aout 1813") was photographed by me. They are specifically the same as the plants cultivated by the younger JACQUIN in 1810 from seed sent from Paris (Mus. His. Nat., located in the Jardin des Plantes), and named by him, *Coreopsis diversifolia.* They are matched specifically also by the type illustration of *Cosmea lutea* Sims.

The cultivated specimens found in herbaria are mostly lower, more delicate, and less erect, giving an illusory appearance of dissimilarity to the spontaneous form. POIRET's description was based upon one of DESFONTAINES' specimens. Like many of the descriptions written in those days, it was inadequately drawn. The fruiting characters were omitted. We read that the plant described is small, with petioles and lower part of stem pilose, also with ovate leaves. These last were not described as compound.

DE CANDOLLE (*loc. cit.*), evidently relying solely upon POIRET's description,[9] maintained *B. grandiflora* apart from *B. serrulata* (Poir.) Desf. The Index

[8] KUNTZE's specimen (*ipse leg.*) came from 2100 m. alt., Santa Rosa, Bolivia, April 1, 1892. It is still extant (Hb. N.Y. Bot. Gard.) and is true *Bidens andicola* H.B.K.

[9] "Ab hac (*B. grandiflora* Balb.) ex descr. videtur diversa *Coreopsis serrulata* Poir. suppl. 3 [*sic*] p. 352 etiamsi a cl. Desf. admissa."

Kewensis (1:617. 1895), however, equates *Coreopsis serrulata* Poir. and *Bidens grandiflora* Balb. Furthermore, we are bound to consider the very careful and extended description of the Poiret species drawn up by the eminent CASSINI (*loc. cit.*) when publishing the new combination *Kerneria serrulata*. CASSINI had been in Paris, at the center of DESFONTAINES' and also of POIRET's activities. He amplified his description from living material growing in the Royal Garden of Paris, where DESFONTAINES had worked. His description fitted very well the average plants of *B. grandiflora*.

Upon the grounds of priority the name *B. serrulata* goes back to some time in the year 1811 prior to Nov. 29,[10] while *B. grandiflora* was not published until in 1812. The exact date for *Coreopsis diversifolia* Jacq. I do not know. The page number and plate number would seem clearly to indicate, however, a date later than 1811. At all events, the existence of a *B. diversifolia* Willd. (*ex.* DC. *loc. cit.* no. 55) might well preclude the acceptance of the combination *B. diversifolia* (Jacq.) Hort. *ex* DC. (*loc. cit.* no. 59).

BIDENS LEPTOLEPIS Sherff, descript. emend.—Herba annua, erecta, glabra vel fere glabra, ramosa, caule tetragona, circ. 4–6 dm. alta. Folia tenuiter petiolata petiolis 1–3.5 cm. longis, petiolo adjecto usque ad 1.1 dm. longa, pinnatim 3–5 (rariter—7)-partita, foliolis membranaceis, lateralibus plus minusve prorsum spectantibus; omnibus nunc elongato—linearibus et 1–2 mm. latis, vel nunc rursus plus minusve partitis segmentis oblongo—linearibus usque ad 5 mm. latis, ultimis lobis versus apicem rotundatis, apice ipso mucronulatis, margine obsolete vel aegre ciliatis et saepe involutis vel revolutis. Capitula ramos terminantia, pedunculata pedunculis 2–7 vel rarius—15 cm. (supra summum jugum foliorum verorum) longis, radiata, pansa ad anthesin 2.2–3 cm. lata et 0.7–1.1 cm. alta. Involucri bracteae (saepe perspicue) dimorphae, exteriores numerosae (11–18), patentes vel recurvatae, (saepe angustissime) linearielongatae, hispidae vel apicem versus glabratae, apice indurato acutae, basi moderate dilatatae, 6–9 mm. longae, interiores ovatolanceolatae, exterioribus subaequales. Flores ligulati 6–8, ligula oblanceolati vel anguste obovati, valde et perspicue atropurpurei vel atro-rubri, apice rotundato plus minusve emarginati et saepe 1–5 dentibus minutis denticulati, 0.9–1.5 cm. longi. Achaenia linearia, exalata, infra sensim supra saepe subabrupte angustata, atra, obcompressa, utraque facie circ. 8—sulcata, faciebus marginibusque saepe minute erecto-setosa, corpore 9–14 mm. longa et 1–1.3 mm.

[10] *Fide* Bibl. Franc.: 83. Nov. 29, 1811; *cf.* Jour. Bot. 44:319. 1906.

lata, quam paleae anguste lineares paulo breviora, apice biaristata aristis retrorsum hamosis, circ. 1.7–2 mm. longis.

This species was described originally by me (BOT. GAZ. **76**:85, Pl. IX, *figs. a–g.* 1923) from a single specimen by *T. Kassner*, no. 2725, under trees, Mt. Kundelungu, Belgian Congo, May 10, 1908 (Hb. Berl.).

Shortly afterwards I was able, fortunately, to enlist the friendly cooperation of MR. F. G. OVERLAET of Belgium. In April, 1925, MR. OVERLAET'S official duties had taken him to Kafakumba, Belgian Congo, where he collected several handsome specimens of this *Bidens*. These, together with various other Congo specimens found by him, were forwarded to me and are now deposited in certain herbaria (Hb. Field Mus., 3 sheets; Hb. Berl.; Hb. Kew). They afford us a much broader and more representative notion of the species than was possible from the single type specimen. The achenes are mature, the leaves are mostly more divided, with shorter and broader segments, and the external involucral bracts are more often numerous than in the type and also often shorter and less noticeably narrowed. The rays of the two dozen or more flowering heads examined vary from dark red to densely dark purplish-red, as in the type.

With the aid of these additional specimens the above amplified description has been drawn.

BIDENS TRIPLINERVIA var. **hirtella** comb. nov.—*B. hirtella* H.B.K. Nov. Gen. et Sp. **4**:182 (232). 1820; *B. procumbens* H.B.K. *loc. cit.*; *B. serrata Pav. ex* DC. Prodr. **5**:597. 1836.—

The type locality of *B. hirtella* H.B.K. and of *B. procumbens* H.B.K. was not definitely known to KUNTH. In the case of the former, he surmised (H.B.K. *loc. cit.*) that the plant had grown with *B. triplinervia* H.B.K., which was known to have been collected in Mexico ("prope San Augustin de Las Cuevas et urbem Mexici"). In the case of the latter, he surmised that it had grown near Jalapa ("Xalapa"), Mexico. An extra sheet of original material matching the type of *B. hirtella* and of the identical *B. procumbens* was in the Bonpland herbarium, which was given later to the Paris Herbarium (Hb. Mus. Hist. Nat.). This was clearly of the same collection as the two types mentioned. It had been labeled (by Spach, *fide L. Aufray coram me in mense Augusto*, 1914) *B. procumbens*. It came from Quito, Ecuador. Without doubt, then, the types of *B. hirtella* and of *B. procumbens*, which had upon their labels no data at all as to locality (except "Amerique Equatoriale"), came from the same locality.

In a former paper (BOT. GAZ. **80**:383. 1925), I have treated *B. triplinervia* as having two sets of forms with divided leaves (var. *mollis* and var. *macrantha*), and one set with undivided leaves (the species proper). From this last set may properly be segregated the forms with slender leaves as var. *hirtella*. KUNTH described the leaves as lanceolate, but they are variously linear-lanceolate, widely linear-oblong, or narrowly oblong-lanceolate. The affinity with *B.*

triplinervia is evidenced by the mostly 5-rayed heads, which alone distinguish the variety from the corresponding variety, next treated, of *B. andicola* H.B.K.

BIDENS ANDICOLA **tarijensis** var. nov.—Folia plerumque indivisa, anguste vel late oblongo-linearia, interdum 1–5-lobata vel 3–5-partita, segmentis linearibus.

K. Fiebrig 3460, Tarija, Bolivia, March 9, 1904 (type, Hb. Berl.); *idem* 3461 *pro parte*, alt. 3200 m., Calderillo, Bolivia, March 22, 1904 (Hb. Berl.); *idem* 3004a *pro parte*, Tarija, Bolivia, in 1904 (Hb. Berl.).

BIDENS ANDICOLA var. TARIJENSIS f. **dissecta** f. nov.—E var. *tarijensi* omnibus foliis pinnatim divisis segmentis elongatis tenuiterque linearibus differt.

K. Fiebrig 3147, alt. 2200 m., Tarija, Bolivia, March 13, 1904 (type, Hb. Berl.); *idem* 3004a *pro parte*, Tarija, Bolivia, in 1904 (Hb. Berl.); *idem* 3461 *pro parte*, alt. 3200 m., Calderillo, Bolivia, March 22, 1904 (Hb. Berl.).

The specimens cited here for the var. *tarijensis* and its f. *dissecta* come from the little known territory in the extreme southern part of Bolivia, close to the Argentine boundary. They are graceful, mostly glabrous plants, growing up to a meter in height. They have a habit more characteristic of *B. triplinervia* H.B.K. (with which they were at first confused by me), but the heads are rather uniformly 8-rayed, as in *B. andicola*. The variety proper is seen to be comparable with the var. *hirtella* of *B. triplinervia*. In var. *tarijensis*, however, there is observed the very strong tendency to produce a form with the leaves divided into 3–5 elongate-linear segments. This form (f. *dissecta*) is very different in general habit from other heretofore known forms of *B. andicola* with compound leaves.[11]

BIDENS PILOSA var. MINOR (Bl.) Sherff, *loc. cit.* **80**:387. 1925; *B. africana* Klatt, Bull. Hb. Boiss. **4**:464. 1896.—

In a former article (Sherff, *loc. cit.*) I have given a list of synonyms for the name *B. pilosa* var. *minor*. To those given there, may be added the name *B. africana* Klatt. KLATT's type was a plant collected by *Dr. C. Keller*, on Reunion Island, summer of 1886. The herbarium containing the type was not cited, nor have I ever succeeded in locating an authentic specimen. At Gray Herbarium, however, are various tracings by KLATT, which form an important part of Klatt's herbarium obtained by that institution some years ago. One of these is of *B. africana*. The plant represented is seen to be widely remote from *B. lantanoides* Gray and *B. hawaiensis* Gray, with which KLATT compared it in his original

[11] We may note an instructive specimen, *K. Fiebrig* 3459, alt. 2800 m., Tarija, Bolivia, March 22, 1904 (Hb. Berl.). This was collected the same day as the Calderillo plants (no. 3461), at a slightly different altitude in a nearby locality. Its leaves are tripartite and more as in normal forms of *B. andicola*.

description. The tracing, construed together with KLATT's description (". . . . Die eiförmigen Strahlblüten sind 2–3 mm. lang . . . ."), shows that the plant itself was, beyond all reasonable doubt, merely a simple-leaved form of *B. pilosa* var. *minor* (Bl.) Sherff.

BIDENS TRIPARTITA L. Sp. Pl. 831. 1753; *B. shimadai* Hay. Icon. Pl. Formos. **8**:60, *fig.* 28. 1919.—

Recently HAYATA has interpreted a simple-leaved plant collected by *Y. Shimada* at Shichiseizan, Formosa, September, 1916, as representing a new species, *B. shimadai*. HAYATA describes the plant as near to *B. tripartita*, but states that it differs "in the simple, not lobed, leaves."

The vast literature of *B. tripartita* includes many names proposed by authors, mainly European, to apply to plants of *B. tripartita* that differ in having the leaves simple rather than tripartite. These names must, in the main, be omitted here. It may be noted, however, that as early as 1838 (Peterm. Fl. Lips. 602) a var. *integra* was proposed to embrace the simple-leaved forms. In general, attempts to treat *B. tripartita* and its varieties or forms upon the basis merely of leaf division (without considering also the achenial characters) are as futile as attempts based upon normal, dwarf, and intermediate growth-habit. In neither case does a natural arrangement result.

While I have not seen the *Shimadai* specimen, nor even any specimen of *B. tripartita* from Formosa,[12] I have examined a considerable number of specimens from Japan proper and from Corea. Among these were several forms which matched the HAYATA description more or less, as to leaves, but were still too close to *B. tripartita* proper to permit segregation.[13]

[12] HAYATA lists, however, a normal specimen of *B. triparitita* from the same locality in Formosa—*T. Soma*, Shichiseizan, March, 1916. He states that *B. tripartita* is new to the flora of Formosa.

[13] Several additional specimens from the same range were found to have the achenes more weakly setose, or even glabrous, upon the margins, and to be referable to *B. tripartita* var. *repens* (D. Don) Sherff.

A complete list of specimens of *B. tripartita* from Corea and Japan, examined by me, follows: *Anon.*, Sakawa, Shikoku Island, Japan, October 10, 1890 (Hb. Berl.); *Abbé U. Faurie* 162, Shonai, Japan, September 22, 1897 (Hb. Berl.; Hb. Univ. Vienna); *idem* 417, Fusan, Corea, October 4, 1901 (Hb. Berl.) *idem* 1171, Mombetsu, Japan, September 27, 1887 (Hb. Kew, 2 sheets); *idem* 3372, Aomori, Japan, October, 1899 (Hb. Berl.); *idem* 4854 and 4855, Kushiro, Japan, September 19, 1889 (Hb. Kew); *Maximowicz*, Hakodate, Japan, 1861 (Hb. Univ. Copenh.; Hb. Mus. Vienna); *idem*, Yokohama, Japan, 1862 (Hb. Berl.); *K. Menjabe*, Azuma, Prov. Iburi, Japan, August 22, 1884 (Hb. Gray); *J. Natsumura*, Tokyo, Japan, September 30, 1879 (Hb. Univ. Vienna); *K. Saida*, Omiya near Tokyo, Japan, July, 1885 (Hb. Berl.); *Y. Tanaka* 20, Japan (Hb. Mus. Vienna); *Taquet* 1028, Hongno, Corea, October 15, 1908 (Hb. Berl.; Hb. Deless.); *Tokubuchi*, Horomambetsu, Prov. Hidaka, Japan, August 20, 1892 (Hb. Mo. Bot. Gard.); *K. Watanabe*, Sakawa, Shikoku Island, Japan, October 11, 1888 (Hb. Gray).

BIDENS ANGUSTISSIMA var. *linifolia* (Schz. Bip. *ex* Klatt) Sherff, BOT. GAZ. **81**:49. 1926; *Coreopsis linearifolia* DC. Prodr. **5**:570. 1836; *Bidens linifolia* Schz. Bip. *ex* Klatt, Flora **68**:203. 1885.—

DE CANDOLLE'S type of *Coreopsis linearifolia* was collected by *Keerl* at Tlapucoya (Tlapujahua), Puebla, Mexico. I myself have not seen DE CANDOLLE'S material ([*ex* Hb. Mart. *in*] Hb. Deless.), but am indebted to Dr. S. F. BLAKE, Associate Botanist, United States Bureau of Plant Industry, for critical notes upon it. Dr. BLAKE examined *Keerl's* plant recently and reported (*in litt.* Jan. 5, 1926) that it belonged to *B. angustissima* H.B.K. From DECANDOLLE'S description and his placement of it among the species with leaves undivided, it is seen at once that the plant is of the var. *linifolia*. We may note in passing that many beautiful specimens of this same variety were collected by *Pringle* not far to the west of Tlapucoya (*Pringle* 6924, alt. 9500 ft., Cerro Ventoso above Pachuca, Hidalgo, Mexico, August 18, 1898;—Hb. Berl.; Hb. Boiss.; Hb. Carn. Mus.; Hb. Deless.; Hb. Field Mus.; Hb. Kew; Hb. Mo. Bot. Gard.; Hb. Mun.; Hb. N.Y. Bot. Gard.; Hb. Par.; Hb. Philad.; Hb. Mus. Vienna; Hb. Univ. Vienna, etc.).[14]

BIDENS AUREA var. **wrightii** (Gray) comb. nov.; *B. heterophylla* var. *wrightii* Gray, Proc. Amer. Acad. **19**:15. 1883; Synopt. Fl. N. Amer. **1**[II]:298. 1884.—

In a former article (BOT. GAZ. **81**:42. 1926), I have shown that the name *B. aurea* (Ait.) Sherff must stand for the plants long known to authors under the synonym *B. heterophylla* Ort. It may be noted here that one of the many forms of this species has seemed distinct enough to various students to warrant maintenance separately as var. *wrightii*. For those who accept such a status the name becomes *B. aurea* var. *wrightii*.

BIDENS SCHIMPERI Schz. Bip. *ex* Walpers Repert. **6**:168. 1846; *B. prolixa* S. L. Moore, Jour. Proc. Linn. Soc. **40**:116. 1911; *B. punctata* Sherff, BOT. GAZ. **59**:302. 1915.—

I have already called attention (BOT. GAZ. **81**:53. 1926) to the "amazing range of variation in all respects" manifested by *B. schimperi* Schz. Bip. *B. prolixa* Moore was founded upon *C. F. M. Swynnerton* 1884, northern Melsetter at alt. 200-600 ft., Rhodesia, April, 1907 (Hb. Brit. Mus.). MOORE (*loc. cit.*) distinguished this plant from *B. schimperi* by "its slender habit with long stalked scattered heads, its smaller leaves with narrower lobes, its smaller heads, shorter involucres and narrower ligules." Upon comparison with a considerable number of specimens of *B. schimperi*, however, *B. prolixa* is found to be connected much too closely for specific separation.

[14] BLAKE had compared the *Pringle* plant with *Keerl's* plant. He stated (*in litt.* Jan. 26, 1926) that "*Pringle* 6924 was a perfect match."

B. punctata Sherff was founded upon two sheets of material (Hb. Kew) consisting of small plants with leaves tripartite or even entire, not bi- or tripinnate as in ordinary *B. schimperi*. Their outer involucral bracts were noticeably shorter than the inner ones. The fruiting characters were very similar to those of *B. prolixa*, and I therefore came later to regard *B. punctata* and with it the less extreme *B. prolixa* as representing a variety (var. punctata comb. adhuc ined.) of *B. schimperi*. The diagnostic characters are found in herbarium specimens, however, to be so uncorrelated and so prone to appear in different combinations, that it seems difficult to justify maintenance even of varietal rank for the *prolixa* or *punctata* forms.

BIDENS SPECIES NATIVE TO ISLANDS OF CENTRAL PACIFIC OCEAN.—In the preparation of a monograph of the entire genus *Bidens*, I have recently completed a conspectus of all the known species and varieties of *Bidens* which are native to the various islands of the central Pacific. This conspectus, together with an analytical key to the species and varieties, is here published separately from the proposed monograph, with the intention of making the results of my studies more immediately useful to various plant workers in the region included:[15]

Key to species and varieties of Bidens native to islands of central Pacific Ocean[16]

a. Leaves commonly undivided:
  b. Inflorescence composed of solitary, pedunculate head:
    c. Leaves tomentose-pubescent.....6. B. lantanoides
    c. Leaves glabrous:
      d. Petioles equaling or surpassing blades...33. B. mauiensis
      d. Petioles shorter than blades:
        e. Leaves broadly cuneate at base, on each lateral margin coarsely dentate with 3–5 teeth.....35. B. cuneata
        e. Leaves rounded or cordate at base, on each lateral margin serrate with 6–15 teeth.....34. B. molokaiensis
  b. Inflorescence composed of few or many heads, cymose or paniculate-corymbose:

[15] Introduced species such as *B. laevis* (L.) B. S. P., *B. pilosa* L., *B. chinensis* (L.) Willd., and *B. tripartita* L. are omitted.

[16] As here taken, extending from the Tropic of Cancer south to slightly past the Tropic of Capricorn (Pitcairn Isl.) and from 130° to 180° W. Longitude.

c. Heads at anthesis minute, 2–4 mm. high:

d. Achenes 6–8 mm. long; species of Hawaiian Islands
11. B. degeneri

d. Achenes commonly 2.5–6 mm. long; species of Southern Hemisphere:

e. Leaves more or less oblong-ovate, shortly acuminate, their thickish petioles 1.2–1.4 mm. wide . . . 1. B. ahnnei

e. Leaves lanceolate-ovate, cordate-acuminate, their slender petioles 0.6–0.8 mm. wide . . . . . 2. B. polycephala

e. Leaves narrower, as a rule narrowly lanceolate or oblong-lanceolate . . . . . 7. B. australis

c. Heads at anthesis larger:

d. Leaves as a rule narrowly lanceolate or oblong-lanceolate:

e. Plants of Marquis Islands:

f. Achenes about 4 mm. long . . . . . 3. B. jardinii

f. Achenes about 6 mm. long . . . . . 4. B. bipontina

e. Plants not known from Marquis Islands (nor from Hawaiian Islands)

f. Heads few (±8 on a single branch) . . 8. B. mathewsii

f. Heads more numerous . . . . . 7. B. australis

d. Leaves broader:

e. Leaves pubescent underneath . . . . . 5. B. cordifolia

e. Leaves glabrous:[17]

f. Stems or branches more or less glaucous; plants of Hawaiian Islands:

g. Exterior involucral bracts 1–2.5 mm. long:

h. Simple leaves ovate or rhomboid-ovate
15. B. ctenophylla

h. Simple leaves oblong-lanceolate
10. B. hawaiensis

g. Exterior involucral bracts about 4–5 mm. long
12. B. asymmetrica

f. Neither stems nor branches glaucous:

g. Leaves ovate-lanceolate, cuneate at base, petioles 1–3 cm. long. Plant known only from Island of Nukahiva (Marquis Isls.) . . . . . 9. B. henryi

[17] Low, bushy, dwarfed forms of *B. graciloides* with simple leaves may be looked for here.

g. Leaves ovate, subcordate at base; petioles 2–5 cm. long. Plant known only from Island of Oahu (Hawaiian Isls.) . . 16. B. macrocarpa var. ovatifolia

a. Leaves commonly divided:

b. Heads large, at anthesis 5 cm. wide; styles surpassing the anthers by 6–10 mm., their branches abruptly long-caudate 36. B. cosmoides

b. Heads smaller; usually only stylar branches projecting above the anthers:

c. Leaves bipinnately divided, their ultimate segments narrow (or in *B. waianensis* sometimes broad):

d. Plants decumbent or ascending:

e. Heads solitary or long-pedunculate 33. B. mauiensis and var. lanaiensis

e. Heads corymbose or paniculate . . 32. B. hillebrandiana

d. Plants erect:

e. Achenes spirally coiled or twisted; segments of leaves broadly linear or wider . . . . . 31. B. waianensis

e. Achenes straight or slightly twisted, 8–12 mm. long, segments of leaves linear or filiform, or if broader then with conspicuously elongate, slender teeth 30. B. menziesii and vars. filiformis and leptodonta

e. Achenes straight or nearly so, about 3 mm. long 19. B. pulchella

c. Leaves ternately or pinnately divided, or sometimes imperfectly bipinnate:

d. Plants decumbent or ascending:

e. Heads solitary, long-pedunculate . . . . 33. B. mauiensis

e. Heads cymose, corymbose or paniculate:

f. Paleae up to 1 cm. long, exceeding the mature, biaristate achenes . . . . . 32. B. hillebrandiana

f. Paleae much shorter and much surpassed by the usually exaristate achenes 11. B. degeneri var. apioides

d. Plants erect:

e. Principal achenial aristae, unless absent, commonly arising from below apex of achene and continuous with achene's margins:

f. Achenes narrow (0.5–1.5 mm. wide), black, wingless; heads at anthesis 4–6 mm. high and 1.5–2 cm. wide:
g. Heads numerous, often densely corymbose or paniculate; mature achenes commonly glabrous upon the face and margins:
h. Mature achenes conspicuously and intensely shining-black; exterior involucral bracts only about 1.5 mm. long
29. B. micrantha and vars. kaalana and laciniata
h. Mature achenes somewhat shiny and becoming black, but not intensely so; exterior involucral bracts larger, mostly 3–5 mm. long
21. B. conjuncta
g. Heads fewer, cymose-corymbose or scattered here and there, mature achenes dull black, setose upon the margins.....28. B. waimeana
f. Achenes broader, brownish, often winged; heads at anthesis 7–8 mm. high and about 3 cm. wide
16. B. macrocarpa
e. Achenial aristae missing or principal ones commonly arising from achenial apex itself:
f. Outer involucre of immature heads reflexed; inner involucre conspicuous and similar to that of *Cosmos bipinnata* Cav. .....27. B. amplectens
f. Exterior bracts of immature involucre erect or spreading:
g. Heads commonly solitary, peduncles up to 11 cm. long, exterior bracts notably foliaceous
25. B. valida
g. Heads and exterior bracts otherwise:
h. Achenes spirally coiled or strongly twisted:
i. Achenes commonly coiled through 3–5 revolutions.....23. B. torta
i. Achenes commonly coiled through not more than 2 revolutions:
j. Cauline leaves large, 3-parted:
k. Flowering heads numerous, small, 4–5 mm. high and about 1.5 cm. wide

22. B. forbesii

k. Flowering heads few, larger, 6–12 mm. high and ±2 cm. wide

24. B. campylotheca

j. Cauline leaves commonly 5–7 parted:

k. Their lower leaflets often alternate; achenes narrowly linear, toward apex narrowly elongate.....13. B. cervicata

k. Their lower leaflets regularly opposite; achenes only slightly narrowed above:

l. Internodes long; leaves few and large; heads few, when expanded 3–4 cm. wide

24. B. campylotheca var. pentamera

l. Internodes short; leaves usually rather numerous, of medium size; heads usually very numerous, single herbarium specimen bearing 50–200, these when expanded only about 1.5–2 cm. wide

31. B. waianensis

h. Achenes straight, curved or only weakly twisted:

i. Branches of inflorescence widely spreading, bearing 1–few heads; internodes of stem and branches commonly long

24. B. campylotheca and vars. nematocera and pentamera

i. Habit otherwise:

j. Leaves commonly 3-parted:

k. Leaflets narrowly lanceolate, crenate-serrate, terminal one long-attenuate at apex; heads not numerous

18. B. asplenioides

k. Leaflets lanceolate to ovate (or, if more elongate, then heads numerous), acutely serrate, terminal one apically acute or acuminate but not long-attenuate:

l. Flowering heads minute, 6–8 mm. wide and 4–5 mm. high

11. B. degeneri var. apioides

l. Flowering heads larger:

m. Stem and branches acutely tetragonal, upwardly herbaceous:

n. Lateral leaflets usually sessile; body of achene 10–16.5 mm. long
21. B. conjuncta

n. Lateral leaflets petiolulate; body of achene 6–9 mm. long
20. B. sandvicensis and var. caduca

m. Stem and branches rounded-tetragonal, scarcely herbaceous above:

n. Mature achenes more or less twisted; exterior involucral bracts shorter by half than interior
12. B. asymmetrica

n. Mature achenes straight or curved, not twisted:

o. Exterior involucral bracts commonly almost, or sometimes fully equaling interior ones
28. B. waimeana

o. Exterior involucral bracts shorter than interior ones by third or half.....14. B. graciloides

j. Leaves more often 5-parted;

k. Heads in clusters of 2–5, on long, slender, erect, naked branches, separately pedunculate on peduncles mostly 2–5.5 cm. long; at anthesis 7–8 mm. high
26. B. stokesii

k. Heads cymose-corymbose or paniculate, with peduncles mostly shorter at anthesis, 4.5–7 mm. high:

l. Achenes glabrous or sparsely setose above:

m. Leaflets narrowly lanceolate, crenate-serrate, terminal one long-attenuate at apex; herb found on the Island of Niihau (Hawaiian Isls.)
18. B. asplenioides

m. Leaflets lanceolate to ovate, acutely serrate, terminal one apically acute or acuminate but not long-attenuate
20. B. sandvicensis

l. Achenes moderately or copiously setose upon margins:

m. Plants commonly 2–5 dm. high:

n. Inflorescence manifestly exserted above leaves
17. B. micranthoides

n. Inflorescence (on plant as a whole) not manifestly exserted above leaves
14. B. graciloides

m. Plants commonly 4–9 dm. high:

n. In habit approaching *B. sandvicensis;* terminal leaflet of a larger leaf having in all about 22–26 teeth
20. B. sandvicensis var. setosa

n. In habit approaching *B. asymmetrica;* terminal leaflet of a larger leaf having in all about 6–16 teeth
28. B. waimeana

Conspectus of species and varieties of Bidens native to islands of central Pacific Ocean[18]

1. B. AHNNEI Sherff, BOT. GAZ. **76**:165. 1923. (PL. 1, figs. *i-p*)—Isl. of Nukahiva (Marquis Isls.).

2. B. POLYCEPHALA Schz. Bip., Flora **39**:360. 1856; *non* Oerst. *ex* Fiek Fl. Schlesien 218. 1881; *Campylotheca polycephala* Schz. Bip.

[18] Cf. footnote 16.

loc. cit.; Coreopsis polycephala (Schz. Bip.) Benth. and Hook *ex* Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 210. 1890; *cf.* Fl. Polynes. Fr. 108. 1892. (PL. I, figs. *a-h*)—Isl. of Nukahiva (Marquis Isls.).

3. B. JARDINII Schz. Bip., *loc. cit.; Campylotheca jardinii* Schz. Bip. *loc. cit.; Coreopsis jardinii* (Schz. Bip.) Drake del Cast.—Isl. of Nukahiva (Marquis Isls.).

4. B. BIPONTINA Sherff, *supra* p. 10. *B. serrulata* Schz. Bip. *loc. cit.; non B. serrulata* (Poir.) Desf. Tabl. Ecol. Bot. Edit. II:130. 1815. *Campylotheca serrulata* Schz. Bip. *loc. cit.; Coreopsis serrulata* (Schz. Bip.) Benth. and Hook. *ex* Drake del Cast. *loc. cit.*—Isl. of Nukahiva (Marquis Isls.).

5. B. CORDIFOLIA Schz. Bip., Flora **39**:361. 1856; *Campylotheca cordifolia* Schz. Bip. *loc. cit.; Coreopsis cordifolia* (Schz. Bip.) Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 208. 1890.—(PL. V, figs. *h-n*)—Isl. of Nukahiva (Marquis Isls.).

6. B. LANTANOIDES Gray, Proc. Amer. Acad. **5**:128. 1861. (PL. V, figs. *a-g*)—Isls. of Eimeo[19] and Tahiti (Society Isls.).

7. B. AUSTRALIS Spreng. Syst. **3**:453. 1826; *Bidens australis* Spreng. *in* Sherff, BOT. GAZ. **81**:32. 1926;—*Coreopsis fruticosa* Forst. Prodr. Fl. Ins. Austr. 91. 1786 (*nomen; non* Vest); *Campylotheca australis* (Spreng.) Less., Linnaea **6**:509. 1831; *Bidens paniculata* Hook. and Arn. Bot. Beech. Voy. 66. 1841; *B. fruticosa* Schz. Bip., Flora **39**:358. 1856 (*non L., non DC.*); *Coreopsis fruticosa* Solander *mss., in* Seemann Fl. Vitiensis 143. 1865–1868.—Isls. of Eimeo[20] and Tahiti (Society Isls.) and also Tonga Isls.[21]

8. B. MATHEWSII Sherff, *loc. cit.* **81**:34. 1926.—Pitcairn Isl.

9. B. HENRYI Sherff, *loc. cit.* **76**:164. 1923. (PL. II, figs. *a-i*)—Isl. of Hiva-Oa (Marquis Isls.).

10. B. HAWAIENSIS Gray, Proc. Amer. Acad. **5**:128. 1861; *Campylotheca hawaiensis* Hillebr. Fl. Hawaii. Isls. 211, 214. 1888; *Coreopsis hawaiensis* (Gray) Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 209. 1890.—Isls. of Hawaii and Lanai (Hawaiian Isls.).[22]

11. B. DEGENERI Sherff, *supra* p. 3; *Campylotheca dichotoma*

[19] Known also as Morea.

[20] Cf. footnote 19.

[21] Known also as Friendly Isls.

[22] Also in Eastern Maui, *fide* Hillebr. *loc. cit.* 214.

Hillebrand Fl. Hawaii. Isls. 211, 212. 1888; *Bidens dichotoma* (Hillebr.) Sherff, *loc. cit.* **70**:98. 1920 (*non B. dichotoma* Desf. Tabl. Edit. I:108. 1804 [—*nomen nudum*]; *et* Cat. Pl. Hort. Reg. Paris. Edit. III:185. 1829).—Isls. of Oahu, Molokai and Maui (Hawaiian Isls.).

12. B. ASYMMETRICA (Lévl.) Sherff, *loc. cit.* **81**:49. 1926; *Bidens gracilis* Nutt., Trans. Amer. Phil. Soc. Ser. II. **7**:368. 1841; Sherff, *loc. cit.* **70**:105 and Pl. XIII. 1920; *non B. gracilis* Torr. *in* Ann. Lyc. N.Y. **2**:215. 1828; *Campylotheca gracilis* (Nutt.) Walp. Repert. Bot. Syst. **2**:618. 1843; *Lipochaeta asymetrica* Lévl., Fedde Repert. Spec. Nov. **10**:122. 1911. (PL. III.)—Isl. of Oahu (Hawaiian Isls.).

13. B. CERVICATA Sherff, *loc. cit.* **70**:99.—1920.—Isl. of Kauai (Hawaiian Isls.).

14. B. GRACILOIDES Sherff, *loc. cit.* **76**:159. 1923. (PL. IV.)—Isl. of Oahu (Hawaiian Isls.).

15. B. CTENOPHYLLA Sherff, *supra* p. 5.—Isl. of Hawaii (Hawaiian Isls.).

16. B. MACROCARPA (Gray) Sherff, *loc. cit.* **70**:97. 1920; *Coreopsis* (*Campylotheca*) *macrocarpa* Gray, Proc. Amer. Acad. **5**:126. 1861.—Isl. of Oahu (Hawaiian Isls.).

B. MACROCARPA var. OVATIFOLIA (Gray) Sherff *supra* p. 7; *B. sandivicensis* var. *ovatifolia* Gray, Proc. Amer. Acad. **5**:128. 1861; *Campylotheca macrocarpa* var. *ovatifolia* (Gray) Hillebrand Fl. Hawaii. Isls. 215. 1888.—Isl. of Oahu (Hawaiian Isls.).

17. B. MICRANTHOIDES Sherff, *loc. cit.* **70**:100. 1920; *B. angustifolia* Nutt., Trans. Amer. Phil. Soc. Ser. II. **7**:369. 1841; *non B. angustifolia* Lam. Encycl. **1**:416. 1789; *Campylotheca angustifolia* (Nutt.) Walp. Repert. **2**:618. 1843.—Isls. of Kauai and Oahu (Hawaiian Isls.).

18. B. ASPLENIOIDES Sherff, *loc. cit.* **70**:101 and Pl. XII, *figs. a-f.* 1920.—Isl. of Niihau (Hawaiian Isls.).

19. B. PULCHELLA (Less.) Schz. Bip., Flora **39**:357. 1856; *Adenolepis pulchella* Less., Linnaea **6**:510, tab. 6. 1831; *Campylotheca pulchella* (Less.) Hillebrand Fl. Hawaii. Isls. 211, 212. 1888; *Coreopsis pulchella* (Less.) Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 210. 1890. (PL. II, figs. *j-p*)—Isl. of Oahu (Hawaiian Isls.).

20. B. SANDVICENSIS Less., Linnaea **6**:508. 1831; Sherff, *loc. cit.* **76**:161. 1923; *B. mutica* Nutt., Trans. Amer. Phil. Soc. Ser. II. **7**:368. 1834; *Campylotheca mutica* (Nutt.) Walp. Repert. **2**:618. 1843; *C. sandvicensis* (Less.) Hillebr. Fl. Hawaii. Isls. 211, 214. 1888; *C. macrocarpa* var. γ Hillebr. *loc. cit.* 215; *Coreopsis sandvicensis* (Less.) Benth. and Hook *ex* Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 210. 1890.—Isls. of Kaui, Oahu, Maui, and Hawaii (Hawaiian Isls.).

B. SANDVICENSIS var. CADUCA Sherff, *supra* p. 7.—Isl. of Molokai (Hawaiian Isls.).

B. SANDVICENSIS var. SETOSA Sherff *supra* p. 6; *B. setosa* Sherff, *loc. cit.* **70**:103. 1920.—Isls. of Kaui and Hawaii (Hawaiian Isls.).[23]

21. B. CONJUNCTA Sherff, BOT. GAZ. **76**:162. 1923.—Isls. of Oahu and Maui (Hawaiian Isls.).—Perhaps only a variety of *B. sandvicensis*.

22. B. FORBESII Sherff, *loc. cit.* **70**:103 and Pl. XIV. 1920.—Isl. of Kauai (Hawaiian Isls.).

23. B. TORTA Sherff, *loc. cit.* **70**:105. 1920.—Isl. of Oahu (Hawaiian Isls.).

24. B. CAMPYLOTHECA Schz. Bip., Flora **39**:359. 1856; *Campylotheca grandiflora* DC. Prodr. **5**:593. 1836; *Coreopsis macraei* Gray, Proc. Amer. Acad. **5**:126. 1861.—Isls. of Oahu, Lanai, and Hawaii (Hawaiian Isls.).

B. CAMPYLOTHECA var. NEMATOCERA Sherff, *supra* p. 7.—Isl. of "Molokai and probably also of Maui" (Hawaiian Isls.).[24]

B. CAMPYLOTHECA var. PENTAMERA Sherff, *supra* p. 4.—Isl. of Maui (Hawaiian Isls.).

[23] *B. sandvicensis* var. *heterophylla* Gray (Proc. Amer. Acad. **5**:128. 1861) was described supposedly from Captain *Beechey's* plant collected on the Island of Oahu, and determined by HOOKER and ARNOTT as *Bidens luxurians* Willd. This specimen is still at Kew in good condition but with capitula too immature for satisfactory determination. The plant is probably a mere growth-form of *B. sandvicensis* Less. GRAY cited "*B. luxurians* Hook. and Arn." as a synonym, but complicated his variety's status by citing material collected by the *U.S. South Pacific Exploring Expedition* under Captain *Wilkes*. At Gray Herbarium I did not find this, but I did find *J. Remy* 281, labeled by GRAY "*B. sandvicensis* var. *heterophylla*." This last plant (*cf.* BOT. GAZ. **70**:97, footnote 9. 1920) is referable to *B. micrantha* Gaud.

[24] *Fide* HILLEBRAND, *loc. cit.* 215.

25. B. VALIDA Sherff, *loc. cit.* **70**:102. 1920.—Isl. of Kauai (Hawaiian Isls.).

26. B. STOKESII Sherff, *loc. cit.* **70**:101 and Pl. XII, *figs. g–o.* 1920.—Isl. of Niihau (Hawaiian Isls.).

27. B. AMPLECTENS Sherff, *loc. cit.* **70**:99. 1920.—Isl. of Oahu (Hawaiian Isls.).

28. B. WIAMEANA Sherff, *loc. cit.* **76**:164. 1923.—Isl. of Kauai (Hawaiian Isls.).

29. B. MICRANTHA Gaud., Voy. Freycinet Bot. Pl. 85 (without description). 1826; *ibid.* 464. 1829; *Campylotheca micrantha* (Gaud.) Cassini, Dict. Sc. **51**:475. 1827; *Coreopsis micrantha* (Gaud.) Gray, Proc. Amer. Acad. **5**:127. 1861; *B. sandvicensis* var. *heterophylla* Gray (excl. syn. B. luxurians Hook. and Arn.), *loc. cit.* 128; *B. remyi* Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 39. 1888 (*non B. remyi* [Hillebr.] Sherff); *Coreopsis remyi* Drake del Cast. *loc. cit.* 210. 1890. —Isls. of Oahu,[25] Lanai, Maui, and Hawaii (Hawaiian Isls.).

B. MICRANTHA var. LACINIATA (Hillebr.) Sherff, *supra* p. 8; *Campylotheca micrantha* var. *laciniata* Hillebrand Fl. Hawaii. Isls. 216. 1888.—Isl. of Maui (Hawaiian Isls.).

B. MICRANTHA var. KAALANA Sherff, *supra* p. 8; *Campylotheca micrantha* var. γ Hillebrand, *loc. cit.*—Isl. of Oahu (Hawaiian Isls.).

30. B. MENZIESII (Gray) Sherff, *loc. cit.* **70**:98. 1920; *Coreopsis* (*Campylotheca*) *menziesii* Gray, Proc. Amer. Acad. **5**:127. 1861.—Isls. of Molokai, Maui, and Hawaii (Hawaiian Isls.). The plants on Maui and Hawaii tend strongly to pass over into the following varieties:

B. MENZIESII var. LEPTODONTA Sherff, *supra* p. 9; *Campylotheca menziesii* var. β Hillebrand Fl. Hawaii. Isls. 216. 1888.—Isls. of Maui and Hawaii (Hawaiian Isls.)

[25] Only one collection is known to me from Oahu, viz. *Ad. von Chamisso*, in 1817. My manuscript cites Hb. Univ. Halle, Hb. Kew and Hb. Petrop. for the Chamisso specimens. I had noted the two specimens at Leningrad (Hb. Petrop.) as being a "forma foliis indivisis." The Kew sheet, now before me, bears several very short branches or ends of branches, with small, simple leaves. These leaves have the thickish texture common to normal *B. micrantha* leaves and do not appear to represent the var. *kaalana*, which variety is the only representative of the species collected upon Oahu for more than a century.

B. MENZIESII var. FILIFORMIS Sherff, *supra* p. 9: *Campylotheca menziesii* var. γ Hillebrand *loc. cit.*—Isl. of Hawaii (Hawaiian Isls.).

31. B. WAIANENSIS Sherff, *loc. cit.* **70**:104. 1920.—Isl. of Oahu (Hawaiian Isls.).

32. B. HILLEBRANDIANA (Dr. del Cast.) Degener, *supra* p. 6; *Campylotheca remyi* Hillebrand Fl. Hawaii. Isls. 211, 212. 1888; *Coreopsis hillebrandiana* Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 209. 1890; *Bidens remyi* (Hillebr.) Sherff, *loc. cit.* **70**:97. 1920 (*non B. remyi* Drake del Cast. Illustr. Fl. Mar. Pacif. 39. 1888); *Campylotheca rutifolia* Lévl., Fedde Repert. Spec. Nov. **10**:123. 1911.—Isl. of Molokai, Maui, and Hawaii (Hawaiian Isls.).

33. B. MAUIENSIS (Gray) Sherff, *loc. cit.* **70**:98. 1920; *Coreopsis mauiensis* Gray. Proc. Amer. Acad. **5**:125. 1861; *Campylotheca mauiensis* (Gray) Hillebrand Fl. Hawaii. Isls. 211, 213. 1888.—Isl. of Maui (Hawaiian Isls.).

B. MAUIENSIS var. LANAIENSIS Sherff, *loc. cit.* **80**:381. 1925; *Campylotheca mauiensis* var. β Hillebrand Fl. Hawaii. Isls. 213. 1888.—Isls. of Lanai and Maui (Hawaiian Isls.).

34. B. MOLOKAIENSIS (Hillebr.) Sherff, *loc. cit.* **70**:97. 1920; *Campylotheca molokaiensis* Hillebrand Fl. Hawaii. Isls. 211, 212. 1888; *Coreopsis molokaiensis* (Hillebr.) Drake del Cast. Illustr. Fl. Ins. Mar. Pacif. 210. 1890.—Isl. of Molokai (Hawaiian Isls.).

35. B. CUNEATA Sherff, *loc. cit.* **70**:102 and Pl. XIII. 1920.—Isl. of Oahu (Hawaiian Isls.).

36. B. COSMOIDES (Gray) Sherff, *loc. cit.* **70**:98. 1920; *Coreopsis* (*Campylotheca*) *cosmoides* Gray, Proc. Amer. Acad. **5**:126. 1861.—Isl. of Kauai[26] (Hawaiian Isls.).

CHICAGO NORMAL COLLEGE

[26] A sheet in Hb. Kew (*Mrs. Francis Sinclair Jr.*) has "Hawaii" on label. It may be, however, that the Hawaiian Archipelago was meant, rather than the Isl. of Hawaii itself.

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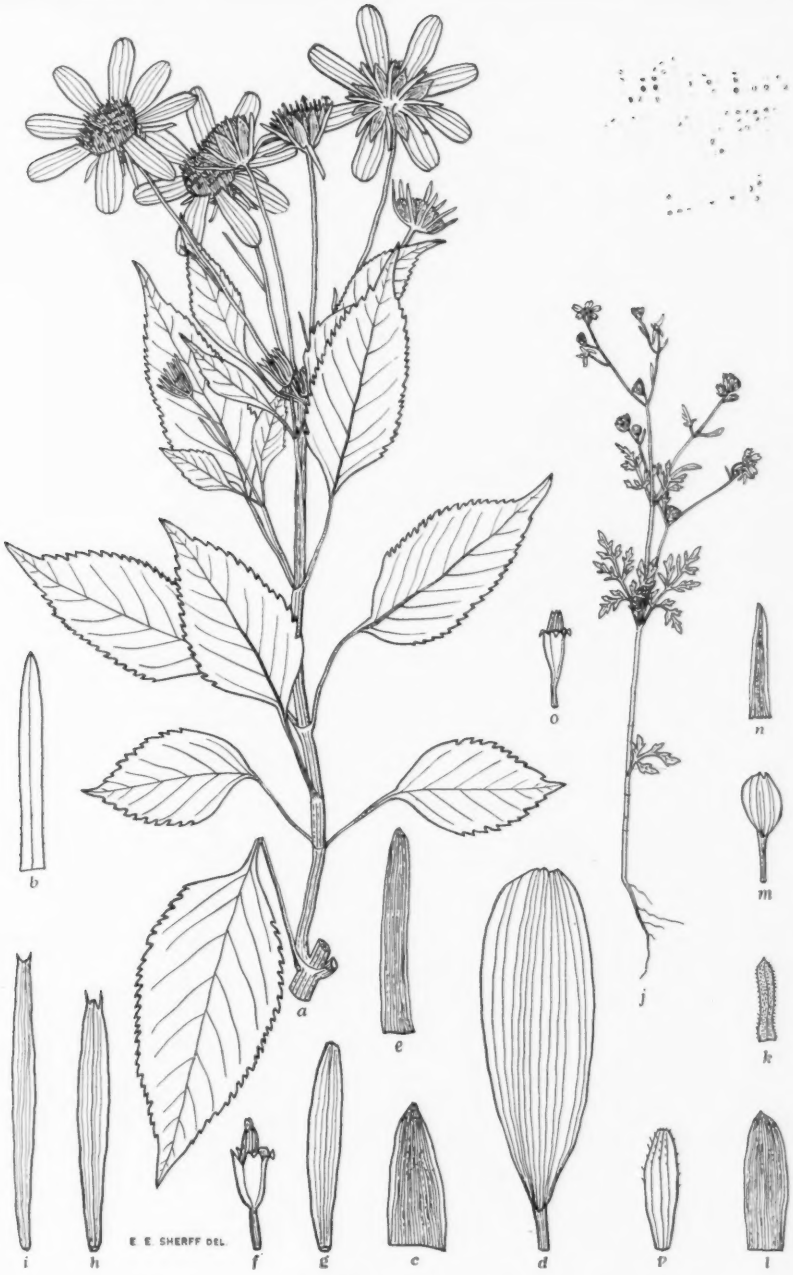
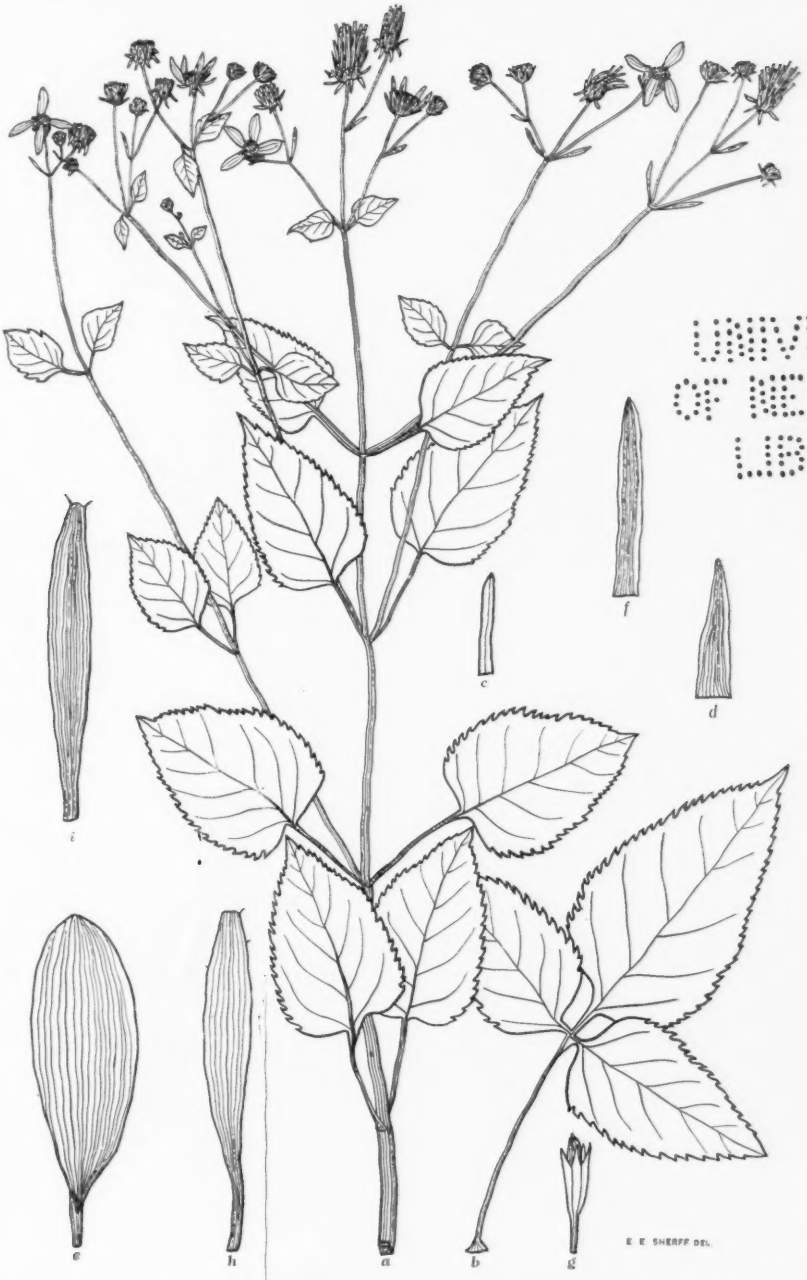
SHERFF on BIDENS



SHERFF on BIDENS



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EXPLANATION OF PLATES I–V

PLATE I

Bidens polycephala: *a*, flowering and fruiting branch, ×0.71; *b*, exterior involucral bract, ×7.1; *c*, interior involucral bract, ×7.1; *d*, ligule, ×7.1; *e*, palea, ×7.1; *f*, disc floret, ×7.1; *g*, *h*, achenes, ×7.1; all from *Ch. Henry*, Mt. Taie Kaoa, Isl. Nukahiva, in 1916, Hb. Field Mus.; *B. ahnnei: i*, flowering and fruiting branch, ×0.71; *j*, exterior involucral bract, ×7.1; *k*, interior involucral bract, ×7.1; *l*, ligule, ×7.1; *m*, palea, ×7.1; *n*, disc floret, ×7.1; *o*, *p*, achenes, ×7.1; all from *Ch. Henry*, mountain near Hakaui, Isl. Nukahiva, in 1916, 1st type sheet of *B. ahnnei*, Hb. Field Mus.

PLATE II

Bidens henryi: *a*, flowering and fruiting branch, ×0.76; *b*, exterior involucral bract, ×4.5; *c*, interior involucral bract, ×4.5; *d*, ligule, ×3; *e*, palea, ×4.5; *f*, disc floret, ×4.5; *g*, *h*, *i*, achenes, ×4.5; all from *Ch. Henry*, Isl. Hiva-Oa, December, 1917, type in Hb. Field Mus.; *B. pulchella: j*, entire plant, ×0.76; *k*, exterior involucral bract, ×6; *l*, interior involucral bract, ×6; *m*, ligule, ×6; *n*, palea, ×6; *o*, disc floret, ×6; *p*, achene, ×6; all from *Adelbert von Chamisso*, Isl. Oahu, in 1816, type of *B. pulchella*, Hb. Berl.

PLATE III

Bidens asymmetrica: *a*, flowering and fruiting branch, ×0.66; *b*, a tripartite leaf, ×0.66; *c*, exterior involucral bract, ×4; *d*, interior involucral bract, ×4; *e*, ligule, ×4; *f*, palea, ×4; *g*, disc floret, ×4; *h*, a 1-awned and *i*, a 2-awned achene, ×4; all from *Abbé Faurie* 960, cotypes in Hb. Brit. Mus. and Hb. Deless.

PLATE IV

Bidens graciloides: *a*, flowering and fruiting branch, ×0.69; *b*, *c*, exterior involucral bracts, ×5.5; *d*, *e*, interior involucral bracts, ×5.5; *f*, ligule, ×5.5; *g*, palea, ×5.5; *h*, disc floret, ×5.5; *i*, achene, ×5.5; all from *C. N. Forbes* 2435 O, type of *B. graciloides*, Hb. Bishop Mus.

PLATE V

Bidens lantanoides: *a*, small branch, ×0.84; *b*, exterior involucral bract, ×4.2; *c*, interior involucral bract, ×4.2; *d*, ligule, ×4.2; *e*, palea ×4.2; *f*, disc floret, ×6.7; *g*, achene, ×4.2; all from *U.S. Explor. Exped.* (*Capt. Wilkes*), Isl. Eimeo, *a* from type in U.S. Nat. Hb.; *b–g*, from cotype in Hb. Gray; *B. cordifolia:* *h*, small branch, ×0.84; *i*, exterior involucral bract, ×4.2; *j*, interior involucral bract, ×4.2; *k*, ligule, ×4.2; *l*, palea, ×4.2; *m*, disc floret, ×6.7; *n*, achene, ×4.2; all from *Barclay* 3213, Isl. Nukahiva, January, 1840, Hb. Brit. Mus.

A MORPHOLOGICAL COMPARISON OF LEAFLETS OF A HYBRID CYCAD AND THE TWO PARENTS

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 376

SOPHIA PAPADOPOULOS

(WITH TWENTY-ONE FIGURES)

Introduction

A generic cross between *Ceratozamia mexicana* and *Zamia monticola* was described by CHAMBERLAIN (3) more than a year ago. About fifty of the hybrids are growing vigorously, and Professor CHAMBERLAIN suggested that I make a detailed study of the two parents and the hybrid, to determine what features of the parents can be recognized in the F_1 generation. I am indebted to him for material and criticism, and wish also to thank Professor LAND for his interest in the work.

The two parents, *Z. monticola* and *C. mexicana*, have been growing luxuriantly for many years in the University of Chicago greenhouse, where they have been under constant observation. *Z. monticola*, the new species described by CHAMBERLAIN (2), was grown from a seed looking like a *Ceratozamia* seed and picked up in a *Ceratozamia* region near Jalapa in Mexico; but upon germination it proved to be a *Zamia*. This is a male plant and produces cones regularly. No female cones of this species are known. Seeds of *C. mexicana* were also brought from the same region, and plants grown from them have proved very hardy and have produced cones.

In April and May, 1924, two cones of *C. mexicana* plants were pollinated with the pollen of two cones from the plant of *Z. monticola*. In November, 1924, these two cones produced a great number of seeds, nearly one hundred, most of which were planted within a period of a few days. These seedlings were repotted in July, 1925, and have since been growing vigorously. The topography and contour of the leaflets of these hybrids have been described by CHAMBERLAIN (3).

Comparatively little work has been done in the anatomy of the leaflets of cycads. The most recent work is that of LAMB (9), who described some features of the anatomy of the leaflets in an attempt to determine whether genera and species of cycads might be determined by the character of the leaflets. In her paper she describes *Z. monticola* as "Z. II," which was then an unidentified species. She also describes the leaflets of *C. mexicana*. KRAUS (8) gives a rather detailed description of the histological characteristics of *C. mexicana*. POOLE (11) in his comparative study lays stress on petioles rather than upon the leaflets.

Methods

For the anatomical study of the leaflets, freehand sections were made through the tip, base, and middle. Younger and older leaflets of *C. mexicana* were sectioned for a more exact study, since the younger ones were more succulent. Only one group of *Z. monticola* leaflets was sectioned, since they were of approximately the same age. In the hybrid, leaflets of the first and second leaves were sectioned separately. In cutting, the tips of several leaflets were put together and bound with a string. These were then placed in a sliding microtome and cut with a razor. With a sharp razor some fairly thin sections can be obtained even though the leaflets are coriaceous.

After being cut, the sections were placed in formalin-alcohol-acetic fixing agent for 24 hours. The proportions used were 10 cc. of commercial formalin, 5 cc. of glacial acetic, and 85 cc. of 50 per cent alcohol. At the end of 24 hours the sections were washed in 50 per cent alcohol for one hour, the alcohol being changed twice.

Two methods were used in staining, safranin with light green and aniline blue with phloxine. The 50 per cent alcoholic safranin was used and specimens were stained for 24 hours. They were then washed, one minute each, in 50, 70, and 85 per cent alcohol respectively. The light green was in 90 per cent alcohol and was very easily absorbed by the leaflets, so that four or five seconds was sufficient for thorough staining. They were then washed in 95 per cent alcohol for one minute, in absolute alcohol for one minute (changing once), in clove oil for one minute or more, in xylol for two or three minutes; they were then mounted in balsam.

Those stained with Magdala red and aniline blue were first

placed in 90 per cent alcoholic solution of phloxine for 24 hours; then dipped in 95 per cent alcohol and stained three or four seconds in aniline blue; then treated a few seconds in 96 per cent alcohol with HCl (a watch-glass full of alcohol with two or three drops of HCl); after which they were washed in 95 per cent alcohol, dehydrated, cleared, and mounted in balsam. Since the acid drew the phloxine very rapidly, some sections were left in that stain for 48 hours.

Description

CERATOZAMIA MEXICANA

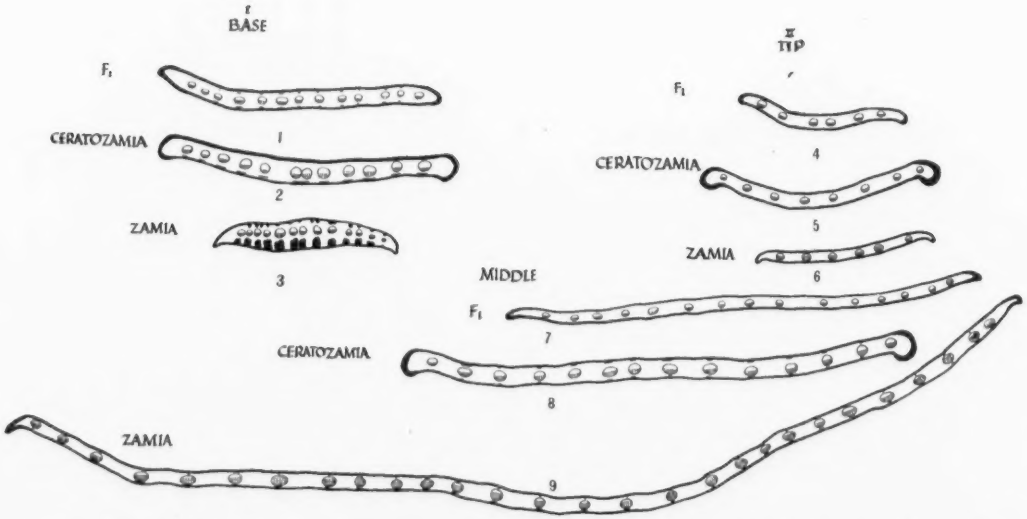
The leaflet of *C. mexicana* is entire, and is described in the manuals as "integerrima." It is narrow, tapering to a rather sharp point at the tip; toward the base there is a gradual decrease in the width of the pinnule to about one-half the width. The surface of the leaflet is very highly cutinized and the edges are revolute. A transverse section through the middle portion of the younger leaflets of *C. mexicana* shows the following characteristics.

The cuticle, which covers the entire surface of the leaf, is thicker on the upper surface of the leaflet than on the lower. The epidermal cells are rather elongated, and pointed with evenly thickened walls. KRAUS describes them as being shaped like prosenchyma cells. The degree of thickening varies in the different cells, and in some of them the lumen entirely disappears, especially in those cells immediately below the bundle in the lower epidermis and those at the revolute edge. The size of the epidermal cells varies; they are more uniform on the upper surface, while on the lower surface they are larger between the bundles and more uniform immediately below the bundles. Both the upper and lower epidermis are interspersed with thin-walled oval cells resembling glands, occurring singly or in pairs. These cells are filled with granular cytoplasm and have large nuclei.

Numerous stomata of a complex type are found in the lower epidermis. They are arranged irregularly through the epidermis, occasionally occurring in groups of two and three, then at times occurring at long intervals.

The number of stomata in a transverse section of the different regions in the leaflets is shown in table I.

The stoma in longitudinal section is a difficult structure to de-



FIGS. 1–9.—Contour of transverse sections through leaflets, showing topography of bundles and regions of sclerenchymatous tissues (in black): 1, transverse section through base of pinnules of F_1; 2, transverse section through base of pinnules of *Ceratozamia;* 3, transverse section through base of *Zamia* leaflet; 4, transverse section through tip of F_1 pinnules; 5, transverse section through tip of *Ceratozamia* pinnules; 6, transverse section through tip of *Zamia* pinnules; 7, transverse section through middle of F_1 pinnules; 8, transverse section through middle of *Ceratozamia* pinnules; 9, transverse section through middle of pinnules of *Zamia;* ×7.

scribe. There are two distinct guard cells immediately below the epidermis. These are very much thickened except at the "hinges," where the wall is quite thin. Where the two guard cells meet, there is a slight curvature and indentation in the beaklike tip. The stomatal opening is rather broad, and at the base near the sides are thickenings. KRAUS describes the stoma in surface view as being surrounded by isodiametric cells, which give the opening an oval shape parallel with the leaf. Above these guard cells are three others, arranged diagonally, which may be considered as auxiliary guard cells.

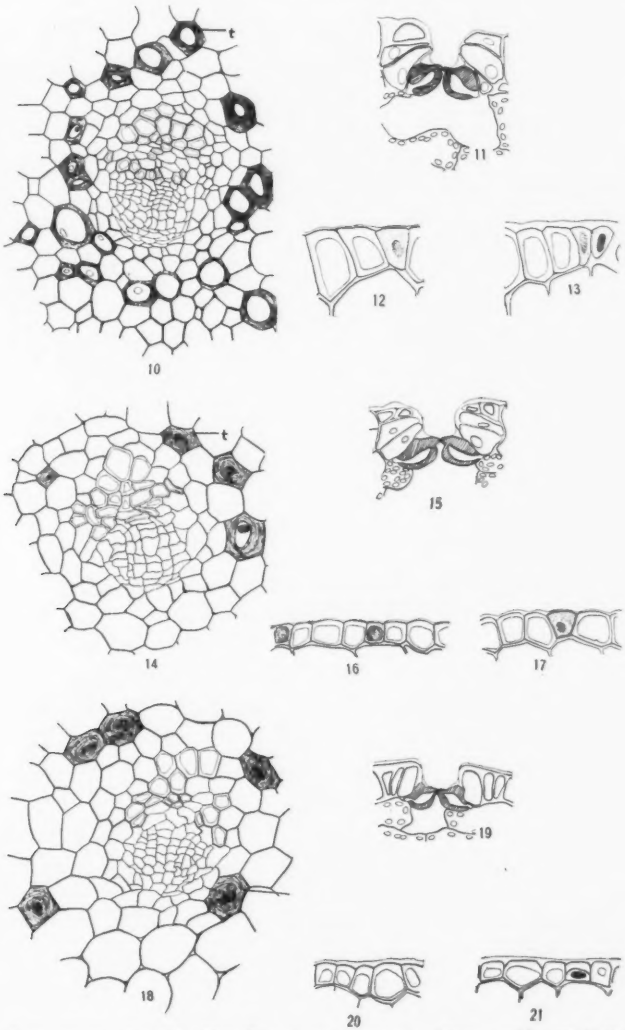
TABLE I

REGION	AVERAGE	MAXIMUM	MINIMUM
	Younger leaflets		
Middle	16	29	10
Tip	10	18	4
Base	14	22	9
	Older leaflets		
Middle	27	33	21
Tip	11	16	7
Base	15	23	10

The two immediately above are triangular with thin walls, whereas the ones at the surface have thickenings and very much resemble guard cells.

Thickened cells occur regularly immediately below the bundles on the lower epidermis, except in those bundles nearest the revolute edge, where these cells may be present in one or two cells, or may be lacking entirely. On the upper surface these thickened cells form in small patches one layer in thickness in the older leaves; in the younger leaves they occur in single cells or in groups of four or five cells. These cells are similar in shape to the epidermal cells, except perhaps that they are rather rounded. The thickness of the walls is even, leaving the lumen very distinct.

The mesophyll consists of two distinct regions, the palisade and the spongy tissue. The palisade is a single layer of rather elongated, compact chlorophyll-bearing cells with the long axis perpendicular



FIGS. 10–21.—Details of bundles, stomata, upper and lower epidermis (*t*, lignified tracheids): 10, vascular bundle of *Ceratozamia;* 11, stoma of *Ceratozamia;* 12, lower epidermis of *Ceratozamia;* 13, upper epidermis of *Ceratozamia;* 14, vascular bundle of F_1; 15, stoma of F_1; 16, upper epidermis of F_1; 17, lower epidermis of F_1; 18, vascular bundle of *Zamia;* 19, stoma of *Zamia;* 20, lower epidermis of *Zamia;* 21, upper epidermis of *Zamia;* ×350.

to the upper epidermis. Below the palisade are two rows of elongated cells of about the same size, which are parallel to the surface. The spongy tissue consists of cells elongated to about three or four times their width, arranged regularly, and parallel to the surface. Some of these cells are yoke-shaped, and where they come together leave oval intercellular spaces. The yoke-shaped cells are more frequent in the older leaves than in the younger ones. KRAUS describes the region below the palisade as palisade parenchyma, and mentions that in the middle of the palisade parenchyma lie the vessels and the bast cells, held together by the cross parenchyma. In this spongy tissue are present sclerenchyma cells with thickened angular walls. These cells are arranged parallel to the palisade region, and occasionally occur in the lower mesophyll. The number of these cells between the bundles varies; in the older leaflets the average near the tip is four, while the maximum number is ten and the minimum two. Toward the base the average is six, while the maximum and minimum numbers are fourteen and four respectively. Through the middle the average is six, while the maximum is eleven and the minimum four. The number of these lignified cells between the bundles is approximately the same in the older and younger leaflets. At the revolute edge they are evenly distributed in the parenchyma.

These thick-walled "bast" cells, found between the bundles and also surrounding them, were found to stain differently in some of the sections. This variation in the staining proved to be due to poor fixation, but suggested a test to determine the nature of this thickening. Several tests for suberin, cutin, and lignin were made.

A 5 per cent aqueous solution of phloroglucin, applied simultaneously with hydrochloric acid, gave all these thick-walled cells a reddish violet color. This test was made with a shaving of wood for comparison, and the color was so identical that it immediately suggested that these walls were lignified. In order to verify this, the solubility and oxidation tests were also tried. The thickenings completely disappeared upon the application of 50 per cent chromic acid; another indication of lignin. The oxidation test with nitric acid and hydrogen peroxide also showed that the membrane had completely disappeared.

Only one test was made for suberin, the iodine and sulphuric acid, but since it showed no reaction at all, the lignin tests were applied and showed quite distinctly that these thick-walled cells in the mesophyll are lignified like the thickened epidermal and hypodermal cells.

Between these bundles, as well as in the spongy tissue, are mucilage canals varying in number from four to none at all. Calcium oxalate crystals are found in the long spongy cells, and occasionally

TABLE II

Region	Average	Maximum	Minimum
	Younger leaflets		
Middle	11	13	9
Tip	8	10	6
Base	11	14	6
	Older leaflets		
Middle	11	14	9
Tip	5	9	4
Base	10	13	7

in the palisade cells. As many as four have been observed in one of the long cells. Stone cells for strengthening are also found in the mesophyll.

The vascular bundles are arranged at even intervals in the spongy parenchyma almost through the center of the leaflet, just a little nearer the lower surface. About eighty sections each, through the tip, middle, and base of the younger and older leaflets were examined. The number of bundles in the middle, tip, and base of the leaflets is shown in table II. There seems to be little variation in the two groups except in the tips of the younger leaflets, where the average is eight.

Each bundle is surrounded first by thickly lignified cells, which are more numerous at the base, and by two or three rows of parenchyma cells. The sclerenchymatous cells have angular walls and laminated thickenings. Some of the walls are so thickened that the lumen entirely disappears. KRAUS describes the bundles as being

surrounded by bast and sieve parenchyma cells, but the tests show quite clearly that these walls are lignified. The bundle is collateral, with the phloem toward the lower surface, arranged in even ladder-like cells with the protophloem at the lower end. The bundle of the pinnules is exarch toward the tip, whereas at the base, near the point of attachment, it is mesarch. A slight variation may occur, since occasionally a mesarch bundle occurs beyond the middle. HILL and DEFRAINE found that in general the bundles of the cotyledons are mesarch, and then become exarch. DORETY, in her study of *Microcycas calocoma*, describes the wood as endarch as far out as the sheathing base of the cotyledon, where it becomes mesarch, while the greater number of strands are mesarch toward the top of the blade and then exarch. This condition seems to hold true also in these pinnules. There is a definite protoxylem point in the center, with the metaxylem above, but in many of the bundles the parenchyma comes up through the xylem on both sides, cutting it into three parts and giving it the appearance of having three protoxylem points.

ZAMIA MONTICOLA

The leaflets of *Z. monticola* are sometimes entire and sometimes serrate near the tip, but are more generally entire in this species. They are quite broad through the center and taper down at the base to about one-fifth their width; at the top there is an abrupt tapering to a sharp point, which gives the leaflet a slightly curved tip. The surface of the leaflets is highly cutinized, especially on the upper epidermis. The epidermal cells are quite uneven in size and thickness, and are larger on the lower epidermis, with thicker walls at the top, giving the lumen a more rounded surface toward the top. The walls of the epidermal cells are rarely thickened to the extent of having the lumen disappear, even at the edge of the leaflet. The edge of these leaflets tapers out rather than being rounded as in *Ceratozamia*.

In the upper epidermis, and only occasionally in the lower, are found some peculiar cells with a very thick upper wall. They occur frequently on the upper surface and are found singly, in pairs, or in groups. These thickenings stain with phloxine, taking about the same color as the thickenings of the guard cells. None have been

observed to form stomata, but where they are arranged in pairs they suggest incompletely developed stomata. The nucleus and protoplasm of these cells have also taken a little of the red stain, showing that they were probably becoming disorganized.

Numerous sunken stomata are scattered in the epidermis with the guard cells immediately below the epidermis. There is considerable variation in the number of stomata in the tip, base, and middle of the leaflets. Table III gives the average number.

Thickened differentiated hypodermal cells occur above and below the bundles, developing toward the bundles rather than being arranged parallel to the epidermis, as in *Ceratozamia*. Only two or three rows of these thickened cells occur at the edge of the leaflet.

TABLE III

NUMBER OF STOMATA IN Z. MONTICOLA

REGION	AVERAGE	MAXIMUM	MINIMUM
Middle	89	112	61
Tip	12	22	8
Base	11	25	6

The palisade layer is not as highly differentiated as is that of *Ceratozamia*. The cells are not distinctly elongated and usually appear rounded.

The spongy mesophyll is very distinct, and also consists of yoke-shaped cells elongated to five or six times their width. When these cells come together they leave an opening varying from a small oval to larger, irregularly shaped spaces. The amount of chlorophyll in these cells varies, but is much greater in those near the palisade than in the layers below.

No thick-walled lignified cells were found in the mesophyll, but stone cells are more numerous. Calcium oxalate crystals are also found through the spongy mesophyll, but are not as numerous as in *Ceratozamia*. Mucilage ducts have not been found to occur in these leaflets.

The bundles of *Z. monticola* are not as large as those of *Ceratozamia*, and are not as strong. They are not surrounded by sclerenchyma cells, although a few are present and are more numerous at

the lower end. The bundles near the base are held to both surfaces by numerous lignified cells, which become fewer and fewer toward the top, leaving the bundles surrounded by two or three rows of parenchyma cells. The bundle is mesarch toward the base of the leaflets, and exarch toward the tip; but mesarch bundles have been found occasionally beyond the middle of the leaflet. There is very little xylem in these bundles, only two or three protoxylem cells and from five to about ten metaxylem cells. The phloem cells are quite even, with the protophloem at the base, and they do not have the crushed appearance of the phloem cells of *Ceratozamia*.

The bundles are evenly distributed throughout the middle, base, and tip, as shown in table IV.

TABLE IV

NUMBER OF BUNDLES IN Z. MONTICOLA

REGION	AVERAGE	MAXIMUM	MINIMUM
Middle	23	30	20
Tip	8	11	6
Base	14	18	9

FIRST LEAVES OF F_1 GENERATION

The first leaflets are entire, rather short and wide, resembling *Zamia* in contour, with the somewhat abrupt tapering at the tip. At the base there is a gradual decrease in width to about one-fifth the maximum width at the middle.

The surface of the leaflets is highly cutinized, the cutin being thicker at the tip than at the base. The upper epidermis consists of rather large, thickened cells of unequal size and thickness. The thickening is greater on the upper and lateral surfaces, but at the base the cell comes to a point. Thickened hypodermal cells immediately below the bundle, parallel to the surface and in groups developing toward the bundle, occur only toward the base of the leaflets. These cells also occur at the revolute edge, varying in number from two to four rows. The edge of the first leaflets varies. Some sections show gradual tapering, with a rounded edge; while in others the narrowing continues, giving it a slightly rounded edge; and some are rounded without any narrowing.

Between the epidermal cells, at regular intervals of four or five

cells, are some very conspicuous cells which have thin walls, very large nuclei, and are full of granular cytoplasm. The walls of the lower epidermis are very much larger, and vary in size and thickness. The thickening here also is greater at the upper and on lateral surfaces, with the pointed thin wall at the base. The lumen of these cells is large and distinct. The thin-walled cells with the large

TABLE V

NUMBER OF STOMATA IN F_1 GENERATION

REGION	AVERAGE	MAXIMUM	MINIMUM
Middle	24	26	15
Tip	4	8	2
Base	6	11	3

nuclei in the upper epidermis are also present in the lower epidermis, but are not quite as numerous.

The stomata are very large and distinct, with the guard cells immediately below the epidermis, and resemble those of both *Ceratozamia* and *Zamia*. Table V shows the distribution of the stomata in the different regions of the pinnules of the F_1 generation.

TABLE VI

LEAFLETS OF F_1 GENERATION

REGION	AVERAGE	MAXIMUM	MINIMUM
Middle	14	16	13
Tip	4	6	3
Base	10	15	7

The bundles are rather small and are arranged at regular intervals in the spongy mesophyll nearer the lower surface. They are surrounded by large parenchyma cells in which lignified cells are sometimes present, varying in number from six to none at all. At the base these sclerenchyma cells surround the bundle completely. Table VI shows that the bundles are more numerous through the center of the leaflet, while at the tip and the base the numbers are approximately the same. The bundles near the base are mesarch, while toward the tip they are exarch. The xylem in these bundles is not very highly lignified except in those near the base, which are

larger and have a greater proportion of xylem and phloem. The phloem cells are arranged generally in ladder-like form, but some appear quite crushed and irregular.

Second leaves of F_1 generation

The second leaflets are longer and broader than the first, and taper to a sharper point. The mesophyll shows very distinct differentiation of palisade and spongy mesophyll. The palisade consists of large, wide, and elongated cells full of chlorophyll, and with large, distinct nuclei. The large, yoke-shaped cells immediately below are also rich in chlorophyll. The length of these cells is six to seven times their width, and they are so rich in cytoplasm that they have an inflated appearance. There are larger intercellular spaces through the spongy mesophyll, as these cells are more deeply yoked.

Large mucilage canals and also calcium oxalate crystals appear in this spongy mesophyll. In the palisade tissue crystals are frequently found in these leaflets. Stone cells and thick-walled lignified cells are also found occasionally between the bundles.

The contour of most of the leaflets is entire, but two of those sectioned have one notch near the tip, which suggests serration.

The histological characteristics of these leaflets is the same as in the leaflets of the first leaf, except that the spongy mesophyll in most of the sections observed is more compactly arranged, in almost parallel rows.

Comparison

The comparison of *Zamia monticola* and *Ceratozamia mexicana* with the F_1 generation cannot be entirely satisfactory, because it is necessary to compare the seedlings of the F_1 generation with the adult parents. Seedlings of the parents are not available.

Upon germination, the seeds of the F_1 generation had two cotyledons, a *Zamia* characteristic; while numerous *Ceratozamia* seeds germinated here twenty years ago showed only one cotyledon. Seeds germinating as they fall naturally on the ground, probably always have only one cotyledon. Dorety (6) produced two cotyledons by germinating on a clinostat, and a few cases have been reported where the two cotyledons developed probably because the seeds were planted in an unnatural position.

A comparison of the leaflets of the first and second leaves shows the leaflets of the first leaf entire and somewhat narrow, although having the contour of the *Zamia* leaflet, with its abrupt tapering to a point. On the other hand, the leaflets of the second leaf occasionally show a suggestion of serration. Leaflets after the second ones also show a slight curving, and they sometimes show single notches.

Transverse sections of both the first and second leaflets show the revolute edge with the characteristics of both parents. Some leaflets are especially interesting, showing a narrowing toward the edge of the leaf, a *Zamia* characteristic, and just at the tip becoming wider and more rounded with three to five rows of lignified cells, which is a *Ceratozamia* characteristic. The same leaflet then shows the characteristic of both parents.

On the whole the epidermal cells show greater thickening at the top and sides, with the thin, rather pointed lower wall, this being distinctly characteristic of *Zamia*.

The epidermis of both the first and second leaflets is interspersed, at almost equal distances, with these thin-walled cells, like the glands found in *Ceratozamia*. These cells are rich in granular protoplasm and have large nuclei. With the aniline blue and phloxine stain the epidermal cells are red, with these cells blue, and they appear very distinctly, while in *Ceratozamia* the blue is not so distinct, probably on account of the disorganization of the cell contents.

The cells of the seedlings proved to be larger and with more protoplasm, while the chlorophyllose cells were filled with large chloroplasts. This condition might have been interpreted as hybrid vigor had we the seedlings of the two parents for comparison, but as it is we can come to no conclusion, since the seedlings of the parents may show the same vigor.

Thickened differentiated hypodermal cells were found only at the base of the leaflets, while toward the top they are replaced by chlorophyll-bearing cells. These thickened hypodermal cells are arranged in such a way as to resemble both parents. On the same leaflet they are observed to be arranged in a single row, parallel to the surface, immediately below the bundles just as in the *Ceratozamia;* while at the top they are found in groups, developing toward

the bundle as in *Zamia*. Others have been observed to be very much as in *Zamia*, in groups, coming toward the bundle.

The bundles near the end are distinctly surrounded by lignified cells arranged in the same position as those of *Ceratozamia*, while toward the top there is a gradual decrease in the number of lignified cells replaced by large parenchyma cells, which is a *Zamia* character. The bundles also are smaller and weaker as a whole, toward the top, with less phloem and with the xylem not very highly lignified.

Mucilage canals as numerous as those in *Ceratozamia* are found between the bundles, while none have been observed in the *Zamia* leaflets. Thick-walled lignified cells varying in number from four to ten, which occurred regularly between the bundles of *Ceratozamia*, appear occasionally in the hybrid leaflets, not exceeding three in number.

Stone cells are found in both parents and in the hybrid, but appear more numerous in *Zamia*, probably for strengthening the large, broad leaves, since the bundles are quite weak.

The stomata of the hybrid show a very interesting development. Those of *Zamia* are slightly sunken, the guard cells having very thick walls, and the pointed ends, which come together, curving upward with two accessory cells. In *Ceratozamia* the stoma is more sunken, with three accessory cells, while the lumen of the guard cells is more distinct. The stomata of the hybrid are somewhat sunken, with two accessory cells, while the guard cells are not as greatly thickened, with a very distinct lumen. The general contour of the guard cells resembles stomata of both parents. Where they come together there are the slightly pointed ends curving upward as in *Zamia*, while immediately below are the two little notches found in *Ceratozamia*. There is also that slight thickening in the lower corners of the stomatal opening present in both parents.

More definite conclusions could be drawn if seedlings of both parents had been available; it is quite clear that the F_1 generation has inherited, rather equally, characteristics of both parents.

Summary

A morphological study of the leaflets of a hybrid cycad obtained from a cross between *Ceratozamia mexicana* and a new species,

Zamia monticola, shows that some of the structures distinctly resemble either one parent or the other, and that other structures show characteristics of both parents. The stomata illustrate the latter point clearly, as they combine distinctly the peculiarity found in the contour of the guard cells in both parents.

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SOME MISUNDERSTOOD PIPERACEAE[1]

LISLE W. MCKOWN

(WITH THREE FIGURES)

I. PIPER CHINANTLENSE MART. AND GAL.

Among the plants collected in Mexico by GALEOTTI was a *Piper* (Gal. 6020) found near the town of Chinantla, on the east slope of the eastern Cordilleras in the Valley of Oaxaca, at an elevation of 3000 feet. It was named and described thus by MARTENS (**18**):

"*Piper chinantlense*. Nobis. (Coll. H. Gal. no. 6020)—Glaberrimum; caule fruticoso, foliis alternis venoso-nervosis coriaceis ovato-lanceolatis acuminatis nitidis basi inaequaliter subcordatis petiolo canaliculato alato caulem amplectentibus, spicis axillaribus solitariis breviter pedunculatis petiolo sesquilongioribus.—Folia 5–6 pollices longa, 3–4 pollices lata.—Affine *Piperi jalapensi* nobis, sed folia subtus glabra."

"On trouve cette espèce dans les belles forêts de la Chinantla, région située sur le versant oriental de la cordillère orientale d'Oaxaca, à 3000 pieds."

The same year and the following, 1843–1844, MIQUEL published his *Systema Piperacearum*. The work of MARTENS and GALEOTTI had evidently been brought to his attention after his book was in the hands of the printer, for he points out in his "corrigenda et addenda" that MARTENS and GALEOTTI'S *Piper chinantlense* is probably synonymous with his own *Artanthe caladiifolia*, his genus *Artanthe* now being classed as a subgenus under *Piper*. He points out (**20**), however, that in his species the spike is only very slightly axillary: "Page 387. N. 9. adde syn.: *Piper chinantlense* Mart. et Gal. l. c. p. 387, sed amenta minime axillaria, ut dicunt."

In 1869, twenty-five years later, C. DE CANDOLLE (**4**) included *Piper chinantlense* among a number of species which he considered doubtful, or which he thought should be excluded. He evidently

[1] The substance of a thesis in candidacy for the master's degree at the University of Illinois, 1926.

took his description from that of MARTENS and GALEOTTI, for reference is made to their original description, and he does not state that he had seen a specimen. HEMSLEY (**14**) in 1882–86 merely mentions *P. chinantlense*, and refers to MARTENS' description and to DECANDOLLE'S reference in the *Prodromus*. *P. chinantlense* is not mentioned even in the index in DECANDOLLE'S analytical key to the Piperaceae (**6**), posthumously published in 1923. The peculiar distinction in the description given by MARTENS is the axillary spike, rather than the spike opposite the leaf, the latter being characteristic of all other true Mexican species of *Piper*. It has already been stated that MIQUEL noted this peculiarity. The species has not been recognized subsequently.

BOURGEAU in 1865 found a *Piper* (Bour. "1898") in the valley of Cordova, above Vera Cruz, northeast of Chinantla, but in about the same botanical region. C. DECANDOLLE named this *Piper cordovanum* and described it thus (**5**):

"*Piper cordovanum.*—Foliis petiolatis oblongis apice acuminatis acumine acuto basi inaequali obtusis obscure viridibus, membranaceis opacis pellucido-punctulatis utrinque glabris, nervis subtus prominulis centrali tota longitudine nervos utrinque 8–10 subopositos subadscendentes mittente quorum supremi ad apicem usque ducti petiolo glabro ad limbi latius minus usque vaginante. Amento quam folium multoties breviote mucronato, pedunculo glabro quam petiolus multum breviore. Bractea cucullata glabra, staminib. 4, antheris obtusis stigmatib. 3, linearibus. In valle Cordova (Bourgeau! 1898 in herb. DC.). Ramuli glabri subtetragoni. Limbi 0,165 longi, 0,07 lati. Petioli 0,035 longi. (v. s.)"

ROVIROSA in 1889 collected a similar *Piper* near San Sebastian, Tabasco, which C. DECANDOLLE named *P. rovirosae* and described thus (**7**):

"*Piper rovirosae* C. DC., n. sp.—Omnino glabrum; foliis modice petiolatis, limbo subovato-oblongo, basi subaequilatera cordato apice breviter acuminato acumine obtus iusculo et breviter mucronulato; nervo centrali nervos arcuatos adscendentes et sat distantes utrinque 5 emittente quorum supremus paullo supra 2/3 longitudinis centralis solutus, petiolo usque ad limbum vaginante; pedunculo quam petiolus breviore, spica quam limbus pluries breviore apice

mucronata, bracteae vertice anguste inflexo, antheris rotundatis quam filamenta paullo longioribus, bacca libera subtetragona, stigmatibus linearibus. . . . . Limbi in sicco rigiduli minute pellucido-punctulati, usque ad 14,5 cm. longi 6,5 lati. Petioli 2 cm., pedunculi 7 mm. longi. Spica matura 3 cm. longa et 2 mm. crassa, ejus mucro fere 2 mm. longus; stamina 4 basi ima baccae adnata, bacca in sicco nigra stigmata 3 sessila. Sebastian in umbrosis, Aprili, vern. Cordoncillo (Rovirosa n. 473, h. Donn. Sm.)."

BUCHINGER at some unascertained time before 1869 collected a *Piper* near Oaxaca, southeast of Chinantla, which DECANDOLLE in the *Prodromus* named *P. rohrii crassum*. He also states that *P. rohrii* equals *Steffensia ampla* Kunth and *Artantha ampla* Miquel, a native of Brazil. C. DECANDOLLE's description of *P. rohrii crassum* is as follows (4):

"*Piper rohrii*.—Foliis petiolatis lato-ellipticis apice breviter acuminatis, acumine acuto, basi subaequali subattenuatis utrinque glabris opacis rigido-membranaceis, nervo centrali subtus prominente utrinque tota longitudine nervos circ. 15 suboppositos subtus prominulos subpatulos mittente, petiolo glabro paullo ultra limbi basin vaginante, alis linearibus, pedunculo glabro quam petiolus breviore, amento maturo quam folium breviore, bracteae cucullatae basi ciliatae vertice triangulari inflexo peltam ciliolatam simulante, bacca glabra. . . . . Ramuli glabri. Limbi 0,21–0,23 longi, 0,11 circ. lati. Petiolo 0,025 longi. Pedunculi 0,012 longi. Amenta mat. 0,09 circ. longa, 0,0035 crassa. (v. s.)"

"β, Crassum, amentis crassioribus, maturis 0,007 crassis, 0,09 longis.—In Oaxaca (Buchinger! in H. Lenormand). (v.s.)"

These four nominal species of *Piper* parallel one another in description except at two places, the leaf size and shape, and the position and size of the spike. The size limits of the first three are practically the same. *Piper rohrii crassum*, however, is distinctly larger. The shape of the leaves may vary slightly within the species, which may account for the variations in the descriptions. It is also possible that the authors had the same general shape in mind, even though the wording of their descriptions varies slightly. The second difference relates to the position and size of the spike. *Piper chinantlense* (Gal. 6020) is the only species of *Piper* reported from Mexico

with axillary spikes. A drawing made by Mademoiselle DURAND for TRELEASE from an original specimen of *P. chinantlense* in the herbarium of the botanical garden at Brussels shows that the spikes really are opposite the leaves, and not axillary, a fact verified on the same material by TRELEASE (fig. 1). *P. rohrii crassum* has larger spikes, but the leaves are also larger, and it is possible that this particular plant (BUCHINGER) grew in a more favorable environment, making it abnormally large, or that it is at least varietally separable from *P. chinantlense*.

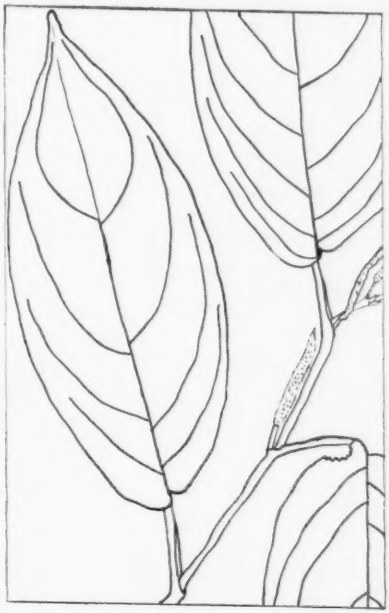


FIG. 1.—Sketch of drawing by Mademoiselle DURAND for Dr. TRELEASE of *Piper chinantlense* (Galeotti 6020), in Univ. Ill. Herb.; from original at Botanical Garden, Brussels.

The species of *Piper* here mentioned came from the same general region in Mexico, the eastern slope of the eastern Cordilleras, between the parallels of 16° and 20° North Latitude, and at a rather low altitude. *P. chinantlense* may appear to be an exception, but it should be remembered that the Cordilleras are relatively low in this particular region, not exceeding 5000 feet. Chinantla is on the eastern slope of a short spur running south or southwest of the main range of the Cordilleras, and is at an elevation of about 3000 feet; hence it might very properly be said to come within the region described.

Herbarium specimens of these species of *Piper* have been observed by TRELEASE in the following collections:

Piper chinantlense.—Near Cordoba, Vera Cruz (Bourgeau 1998 [noted as 1898], in the Candollean Herbarium at Geneva; also 1988

in U.S. Nat. Herb.; New York Bot. Gard.; the Copenhagen Bot. Gard.; and at the Muséum d'Histoire Naturelle at Paris,—the cotypes): near Orizaba, Vera Cruz (Bourgeau 1353, 1528 at Paris; Botteri and Sumichrast 186 at Paris; Gouin, at Paris): near Mirador, above Jalapa, Vera Cruz (Endlich 1153, at the Bot. Gard. Dahlem, Berlin; Seler at Dalhem): near Coatzacoalcos, Vera Cruz (C. L. Smith 1166, the leaves more broadly elliptical, 8×16 cm., rather deeply cordulate, in the U.S. Nat. Herb.; New York Bot. Gard.): near Motzorongo, Vera Cruz (Nelson 157, U.S. Nat. Herb.).

Piper rohrii crassum, reported in type description from near Oaxaca, Oaxaca (Buchinger in Herb. Le Normand), is known only from the one collection.

Another *Piper* at present undescribed was collected near Coahuayutla by EMRICH. This specimen is quite similar to the foregoing, except for the very short spikes. Coahuayutla, moreover, is west of the general locality in which the other specimens were found, and in a different botanical region. It is probable, therefore, that it is a different species.

From the facts assembled it seems reasonable to conclude that *Piper rovirosae* of the state of Tabasco is hardly separable from *P. cordovanum* of the state of Vera Cruz, and that this is clearly the same as *P. chinantlense* of the state of Puebla; hence all should be known as *P. chinantlense*, which has priority of a quarter of a century over *P. cordovanum* and of nearly a century over *P. rovirosae*.

No other species closely comparable with the Brazilian *P. amplum* or *P. rohrii* having been found so far in Mexico, it is not improbable that *P. rohrii crassum*, collected only once in the state of Oaxaca, not far from Chinantla, is a broader-leaved form of *Piper chinantlense*.

II. PIPER JALAPENSE

C. DECANDOLLE (7) in a posthumously published paper in 1920 named and described a plant as follows:

"*Piper botteri* C. DC., n. sp.—Ramulis glabris; foliis magnis longiuscule petiolatis, limbo oblongo-elliptico basi leviter inaequilatera breviter cordato apice breviter et acute acuminato, supra glabro subtus ad nervum centralem longe piloso et ad laterales breviter hirtello, nervo centrali nervos arcuato-adscendentes utrin-

que 4–5 emittente quorum supremus paullo supra medium centralis solutus, nervis ejus lateralibus utrinque 2–3 utrinque a basi solutis, petiolo usque ad limbum vaginante dorso pilis longis haud densis adpresse munito; pedunculo quam petiolus multo breviore glabro, spica florente quam limbus 4-plo breviore sat crassa et apice longe mucronata, bracteae vertice inflexo triangulari margine subglabro pedicello lato utrinque villoso et dorso subproducto, antheris ovatis quam filamenta brevioribus, ovario libero subtetragono glabro, stigmatibus linearibus."

"Ramuli spiciferi 5 mm. crassi. Limbi in sicco membranacei minute pellucido-punctulati, usque ad 27 cm. longi 13 lati. Petioli 7 cm. Pedunculi fere 1 cm. longi. Spica 5 mm. crassa, ejus mucro 1 cm. longus, stamina 4, stigmata 3 sessilia."

"Orizaba (Botteri et Sumichrast n. 1526, h. Van Heurck.)."

In 1869 C. DE CANDOLLE (**4**) in the *Prodromus* had described *Piper novae-hispaniae* in almost the same terms, as the following quotation will show:

"*P. novae-hispaniae.*—Foliis petiolatis late suboblongo-ellipticis apice breviter acuminatis, acumine acuto, basi inaequali cordatis supra glabris basi ad nervum centralem adpresse hirtis subtus ad nervos nervulosque hirsutis membranaceis subopacis subtilissime pellucido-punctulatis, nervis subtus subprominulis, centrali ad 1/2–2/3 longitudinis nervos alternos subadscendentes utrinque 7 supremos ad apicem ductos mittente, petiolo dorso hirtello ad limbi basin usque vaginante, pedunculo glabro quam petiolus triplo breviore, amento florente quam folium multoties breviore cylindrico mucronato, bracteae cucullatae basi dorso hirsutae vertice inflexo peltam triangularem simulante. In Nova Hispania (Pav.! in h. Boiss.). Ramuli glabri. Limbi 0,16 longi, 0,09 lati. Petioli 0,025 longi. (v.s.)"

MARTENS and GALEOTTI in 1843 (**18**) had given essentially the same description to their *Piper jalapense.*

"*Piper jalapense*, Nobis. (Coll. H. Gal. no. 6012).—Caule fruticoso glabro, foliis alternis venoso-nervosis ovato-oblongis acuminatis basi inaequaliter subcordatis supra laevigatis subtus in nervis ac venis pilosiusculis, spicis breve pedunculatis oppositifoliis petiolo sesquilongioribus. Folia 7–8 pollices longa, 4–5 pollices lata, petioli $1\frac{1}{2}$ pollicares alati amplexicaules."

"Croit dans les bois humides et au bord des ruisseaux de Xalapa et de Mirador, de 3,000 pieds à 4,500 pieds. Fl. vertes. Juin."

KUNTH (16) in 1839 had already described the same plant when he spoke of *Schilleria lapathifolia*, although his description was based on a specimen collected by SCHIEDE.

"*Schilleria lapathifolia*.—Ramulis glabris; foliis suboblique ellipticis, breviter acuminatis, basi inaequaliter cordatis, membranaceis, pellucide glanduloso-punctulatis, supra glabris et nitidis, subtus in nervo, venis et venulis hirto-pubescentibus; petiolis utrinque membranaceo-alatis, dorso pilosis, pedunculum triplo superantibus; spicis erectis, rectis, folio multoties brevioribus; bracteis cucullatis, margine, ciliatis; ovariis inferne connatis?; stigmatibus 3, recurvatis, fructibus. . . . ."

"*Piper macrophyllum* Cham. et Schlecht. in Linnaea 5:73. (excl. synon.)."

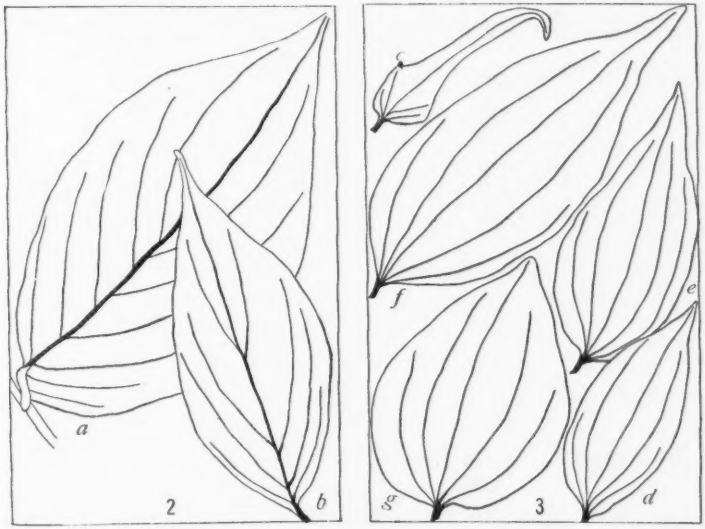
"Crescit in sylvis prope Jalapam Mexicanorum."

"Ramuli flexuosi, exsiccati angulat, glabri. Folia alterna, petiolata suboblique elliptica, breviter acuminata, basi inaequaliter cordata, reticulato-venosa, venis primariis utrinque 7–8 nervoque medio subtus prominentibus, infimis parum approximatis, membranacea, subtilissime glanduloso-punctulatis[sic!], glandulis croceis, pellucidis, supra glabra et nitida, subtus pallidiora inque nervo, venis et venulis hirto-pubescentia, 10-pollicaria, 5 pollices lata. Petioli $1\frac{1}{2}$–2-pollicares, utroque margine membranaceo-alati, dorso pilosi. Spicae oppositifoliae, solitariae, erectae, rectae, cylindraceae, mucronatae, subbipollicares, crassitie pennae gallinaceae; pedunculo 4–6 lineas longo, glabro. Flores densi. Bracteae cucullatae, subtriangulares, carnosae, glabrae, margine ciliatae. Stamina quot?. Filamenta filiformia, fusca, glabra, persistentia. Antherae reniformes, biloculares. Ovaria abbreviata, glabra, inferne connata. Stigmata 3, sessilia, elongata, crassiuscula, recurvata. Fructus. . . . Praecedenti [Schilleria aurita] valde affinis."

STEUDEL (23) in 1841 used the species name *lapathifolium* of KUNTH, but, as was his custom, put the species under the genus *Piper*.

Apparently neither C. DE CANDOLLE in describing *Piper botteri*, nor MARTENS and GALEOTTI in describing their *P. jalapense*, identi-

fied their specimens with the descriptions in the earlier publications of STEUDEL or KUNTH, but since all the descriptions are identical in essentials these are one and the same species, which should be known by the name of *P. lapathifolium* (Kunth) Steud., the first name given to it under *Piper*.



FIGS. 2, 3.—Fig. 2: *a*, *P. jalapense* Steud. (Galeotti, Kew), collected near Jalapa; *b*, *P. oblongum* Mart. & Gal. (Galeotti 6009, Brussels), collected near Jalapa; fig. 3, *c*, *P. amalago subpanduriforme* Trelease, from leaf of type specimen in Vienna Herbarium, part of which is now in University of Illinois Herbarium (Wullschlaegel 130); *d*, *P. amalago* Linn. from photograph now in University of Illinois Herbarium, of type specimen in Linnaean Herbarium; *e*, *P. medium* Jacq., from tracing of sketch in Icones Plantarum Rariorum v. 1. p. 2. t. 8 (1781) 93; *f*, *P. longum arboreum*, etc. Sloane, from notes of Trelease (taken from publications of Sloane and Plukenett (21), (22); *g*, *P. amalago* Pluk. (also taken from same publications).

Piper jalapense C. DC., which is the *Artanthe jalapensis* Miq. (based on Gal. 6009), is not the same as *P. jalapense* Mart. and Gal. (based on Gal. 6012), as the following description by MIQUEL (20) will show if it is compared with that given by MARTENS and GALEOTTI (fig. 2*a*):

"*Artanthe jalapensis.*—Ramulis petiolisque hispidulo-hirtis, foliis

rigido-membranaceis obsoletissime pellucido-punctulatis, supra opacis verrucis et pilis rigidis sensim deciduis asperis, subtus pallidioribus epunctatis in nervo costis venulisque pilis mollibus dense pubescentibus, oblongis vel obovato-oblongis, versus basin attenuatam inaequilateris, basi ipsa inaequali obtusiusculis, apice suboblique acuminatis, costis utrinque 6 rarissime 7, amentis cylindricis, rectiusculis mucronatis folio brevioribus, pedunculo petiolum superante, bracteis peltatis pelta suborbiculari fere tota hirto-ciliata."

"Habitat in m. Cordilleras ad 4,000 p. alt., prope Jalapa Regni mexicani (Gal.! 6009 in h. DeLess.)."

"Frutex *A. asperifoliae* nimis fortasse propinquus sed quantum ex unico ramulo dijudicandum, foliorum forma oblonga vel obovato-oblonga, versus basin attenuata, pilis subtus densioribus et mollioribus, punctorum nigrorum defectu, amentis longius pedunculatis pro diverso habendus. Ramulus in sicco subtetragonus patentim et implexe hirtus, sensim glabratus et asperior, internodiis 3–4½ cent. longis. Folia patentia, rigido membranacea non nisi ad lentem sparsissime pellucido-punctulata, supra saturate viridis opaca, verrucis albis rigidis pilisque verrucis insertis sursum directis sensim deciduis asperrimis admodum aspere subtus glaucescentipallida, punctis nigris haud notata, in nervo costis venulisque pilis mollibus appressis dense puberula, nascentia fere sericea, petiolis hirtis et antice canaliculatis 1–1½ cent. longis sustenta, oblique oblonga et obovato-oblonga, inaequilatera, pleraque versus basin contracta, basi ipsa inaequali obtusa, raro in summis acutiuscula, apice longius acuminata, acumine acuto, marginibus subrepandis planiscula, 13–19 cent. longa, 4–7 lata; e nervo medio percurrente utrinque usque ad ½ circiter alt. 6, rarissime 7 costa; exceptis infimis tenuioribus, alte versus et juxta margines adscendentes oriuntur, quarum summa in acumen nec tamen ad ultimum apicem ducitur. Anastomoses subhorizontales parallelae prominentes. Stipula oppositifolia lanceolata naviculares curvula puberula 1½ cent. longa. Amentum submaturum erectopatulum, pedunculo hirtello fere 2 cent. longo sustentum, leviter curvatum, cylindricum apice breviter mucronatum, 8 cent. longum 3 mm. propemodum crassum, adspectu griseum. Flores annulati. Bractea pedicellata peltata pelta subrotunda, area per-

exiqua centrali nuda caeterum hirto-ciliata pilis sordide flavis. Antherae effoetae castaneo-fuscae reniformes (sec. sp. cit.)."

Since these plants are not the same, and since *Piper jalapense* Mart. and Gal. was named prior to *P. jalapense* (Miq.) C. DC., even though as shown above it as well as *P. botteri* appears to be synonymous with *P. lapathifolium*, according to the Neo-American code the name *jalapense* is not applicable in the latter case. Hence the name **P. pseudo-jalapense** nom. nov. may be used to designate *P. jalapense* (Miq.) C. DC.

In the Brussels Herbarium, under the number Galeotti 6009, there are two separate and distinct species, one the foregoing *P. jalapense* C. DC., which is a scabrous and hairy plant, the other a smooth and smaller-leaved almost entirely glabrous species, which MARTENS and GALEOTTI (**18**) believed to be *P. oblongum* H. B. K. (**15**) (fig. 2*b*).

It chances that two separate and distinct Mexican species have been called *Piper oblongum* H. B. K., which is a Venezuelan plant (Willd. Herb. no. 671). CHAMISSO and SCHLECHTENDAL (**2**) referred a Mexican plant to *P. oblongum*, but KUNTH (**16**), the author of the Venezuelan species, nine years later made a new species of it, calling it *Steffensia oblonga*, in contrast to his *Schilleria oblonga* which is the true *P. oblongum* H. B. K. MIQUEL (**20**) held the same view in 1844, when he called the former *Artanthe chamissonis* and the latter *A. oblonga*. C. DE CANDOLLE (**4**) in 1869 used MIQUEL'S specific names with the generic name *Piper*, to designate these two plants. It will not be necessary, therefore, to consider *P. oblongum* Cham. and Schlecht.

The following description of *Piper oblongum* H. B. K. by KUNTH is taken from *Linnaea*, vol. 13, p. 696, because it is more complete than that first given by KUNTH in H.B.K.

"*Schilleria oblonga*.—Ramulis glabris; junioribus obsolete tuberculatis; foliis breviter petiolatis, elliptico-oblongis, acuminatis, basi aequalibus vel inaequalibus ibique acutis vel obtusis, membranaceis, obsolete pellucido-punctulatis, opacis, glabris, subtus in nervo et venis obsolete puberulis; spicis rectis, folio 1/3 brevioribus; pedunculo petiolum subaequante; bracteis inflexo-peltatis, ciliato-villosis; fructibus obovato-turbinatis trigonis; semine laevi."

"*Piper oblongum* Humb. et Kunth, Nov. Gen. 1:52. Willd. Herb.

no. 671 (fragmentum). *Piper secundum* Willd. Herb. No. 647 majore parte (excl. synon.)."

"Crescit in Nova Andalusia, prope Cumanacoam."

"Rami nodosi, teretiusculi, exsiccati sulcati, glabri; internodiis $1\frac{3}{4}$–2 pollicaribus, ramuli juniores obsolete tuberculati; internodiis $\frac{1}{2}$–1 pollicaribus. Folia alterna, breviter petiolata, elliptico-oblonga, acuminata, acumine acuto, basi inaequalia vel aequalia ibique acuta vel obtusa, reticulato-venosa, venis utrinque 4, subparallelis nervoque medio subtus prominentibus, membranacea, obsolete pellucido-punctulata; utrinque glabra, opaca, subtus pallidiora inque nervo medio et venis obsolete puberula $4\frac{3}{4}$–5-pollicaria, 24–26 lineas lata. Petioli 2–$2\frac{1}{2}$ lineas longi, glabri. Stipulae. . . . . Spicae oppositifoliae, solitariae, pedunculatae, rectae, cylindraceae, $3\frac{1}{4}$ poll. longae; fructiferae crassitie pennae columbinae; pedunculo 3 lineas longo, glabro. Fructus densi, sessiles, solubiles, bracteis interpositis totidem inflexopeltatis, vertice triangularibus ibique margine ciliato-villosis, obovato-turbinati, trigoni, apice rotundato-truncati, stigmatibus tribus persistentibus coronati, glabri, magnitudine grani *Papaveris dubii*. Semen fructi conforme obovatum, trigonum, laeviusculum, castaneofuscum, opacum(?)."

"*Piper oblongum* Schlechtend. et Cham. in Linnaea **5**:73. (excl. synon.) ex Mexico est *Steffensia oblonga* Kth." (**16**).

As previously mentioned, MARTENS and GALEOTTI identified their Mexican plant with the Venezuelan species. In addition to the wide geographical break in the habitat of the two species, there is a difference in the form of the plants. TRELEASE, while visiting the Brussels Herbarium, made the following description of the smooth *Piper oblongum* of MARTENS and GALEOTTI (Gal. 6009 in part).

"Stem glabrous; leaves unequally lance-oblong, rather long-acuminate, rather rounded at the base with one side subacute and slightly longer, moderate (scarcely 5.5×13–15), pinnately veined from below the upper or middle third, veins 4–6×2, glabrous and rather glossy above, somewhat pubescent on the nerves beneath; petiole short (5 plus 2 mm.), not winged, slightly pubescent; spikes opposite the leaves, moderate (2–70 mm.); peduncle rather short (1 cm.), glabrate; bracts round-subpeltate, ciliolate; flowers sessile,

perfect. Type locality: Jalapa, Vera Cruz. Distribution: Eastern Sierra Madre, Mexico."

A critical comparison of these two descriptions of the specimens comprised under Galeotti 6009 proves that two separate and distinct plants are under discussion. Since the name *Piper oblongum* applies to another species, the MARTENS and GALEOTTI plant (Gal. 6009 in part at Brussels) may be known as **P. pseudo-oblongum,** nom. nov., with the foregoing description.

In the sense here used *Piper lapathifolium* is represented in the following principal collections of the world: Jalapa, Vera Cruz (Pringle 8067, Berlin, Field Museum, U.S. Nat. Herb., New York Bot. Gard.; Endlich 1412, Berlin; Galeotti 6012, Paris, Delessert Herb.; Schiede 2, Berlin): near Orizaba (Botteri and Sumichrast 1526, Van Heurck Herb.): Nova Hispania (Pavon in Herb. Boiss.).

Piper pseudo-oblongum is represented by Galeotti 6009 in part, at Brussels, collected near Jalapa and Mirador, Vera Cruz.

Piper pseudo-jalapense is represented by the collections of GALEOTTI and PRINGLE; near Jalapa, Vera Cruz (Pringle 8074, New York Bot. Gard., U.S. Nat. Herb., Brussels, Field Museum, Kew) (Galeotti at Kew, 6009 in part at Brussels).

A study of the descriptions of *Piper botteri* C. DC., *P. jalapense* Mart. et Gal., and *P. novae-hispaniae* C. DC. proves these species to be synonymous with *P. lapathifolium* (Kunth) Steud. Since the name *P. jalapense* was used by MARTENS and GALEOTTI in 1843, according to the Neo-American code it would not be available for use again, hence MIQUEL'S *Artanthe jalapense,* which is synonymous with C. DECANDOLLE'S *P. jalapense,* may be known by the new name suggested above, *P. pseudo-jalapense.* The *P. oblongum* of MARTENS and GALEOTTI, which is part of the Galeotti 6009 at Brussels, is not synonymous with *P. oblongum* of Humboldt, Bonplandt, and Kunth, and hence cannot be known by that name; but it may be called, as stated previously, *P. pseudo-oblongum.*

III. PIPER AMALAGO SUBPANDURIFORME

While WULLSCHLAEGEL, a missionary, was stationed at Fairfield, Springfield, and Chatam, in the parish of Manchester, Jamaica, he collected a number of plants, one of which was a *Piper,* the only one

of its kind ever reported (fig. 3*c*). In 1853 MIQUEL (**19**) named and described this plant in the following manner:

"*Enckea subpanduraeformis.*—Foliis supra partem unam quartam quintamve obovatam vel subdeltoideam abrupte utrinque in sinum coarctatis indeque longe lineari-lanceolatis, basi inaequali obtusa tenuiter quintuplinerviis, in parte lanceolata transverse tenere multinerviis, submembranaceis, glabris, nascentibus tenerrimis quibusdam pilis subtus inspersis, amentis pedunculo glabro petiolum superante suffultis, rectiusculis, densiuscule puberis, folio brevioribus, subdensifloris, bracteis conchaeformibus sursum glabris, ovario ovato glabro, stigmatibus 3 brevissimis (albidulis)."

"In Jamaicae insulae umbrosis detexit venerat. WULLSCHLAEGEL, S. Fidei Evangelicae Missionarius. Vidi in Herb. Martii."

"Habitu, ramificatione scil. dichotoma, ramis ramulisque valde nodosis, nodis perfacile separabilibus, internodiis tenuiter longitrorse striulatis, stipulis parvulis oppositifoliis curvulis hic illic persistentibus, amentorumque fabrica congeneribus suis quam simillima species, *E. discolori* aliisque ex angusta foliatarum phalange proxima, longe a totius ordinis norma discedere videtur foliis prope basin sinu utrinque subpanduraeformiter excisis, fere ad trilobatam forman enintentibus, parte scil. infra sinum sublobato-exserta brevem lobulum utrinque exhibente, terminalem longissimum angustatumque fulciente. Petioli 1–2 lin., folia 2–3 poll. longa, basi 2–6 lin., superne $1\frac{1}{2}$–$2\frac{1}{2}$ lin. lata, discolora, supra siccitate subnigrescentia, subtus fusculo-viridula, impunctata, basi leviter inaequalia, sursum attenuata, marginibus subrepanda. Amenta cum pedunculo circiter $1\frac{1}{2}$-pollicaria, juvenilia densiflora subflaccida, adultiora magis stricta, recta, erecto-patula. Stamina 4 subsessilia, ovario regulariter circumposita, antheris fusco-luteis cordatis, loculis connectivo nunc nigrescente diremtis, in fructu vix omnino persistentia."

In the *Prodromus* C. DECANDOLLE (**4**) replaced the name *Enckea subpanduraeformis* by *Piper panduratum*, but later (**8**) used the specific name given by MIQUEL (changed in spelling by replacement of *i* for *ae*), retaining the generic name *Piper*, since he did not admit *Enckea* as a separate genus. GRISEBACH (**12**), however, six years after MIQUEL's publication, believed WULLSCHLAEGEL's specimen to be a form of *Piper amalago*, and refers to it as *P. amalago variifolia*

Miq. The "Miq." probably refers to MIQUEL's *Enckea subpanduraeformis;* but no reference can be found indicating that MIQUEL had called it a variety of *P. amalago,* or had applied to it the trivial name *variifolia.* FAWCETT and RENDLE (**11**) in 1914 used GRISEBACH's name, substituting, as is customary, the generic name *Piper* for *Enckea.* In a recent publication TRELEASE (**24**) refers incidentally to it as *P. amalago subpanduriforme.*

WULLSCHLAEGEL collected another specimen of *Piper* between Fairfield and Nazareth, which is practically the same locality in which he found the form previously described. C. DECANDOLLE (**4**) named and described this plant as follows:

"*Piper wulfschlaegelii.*—Foliis breviter petiolatis lanceolatis subovato-lanceotis [sic!] apice acuminatis, acumine acuto, basi aequali acutis utrinque glabris siccis rigido-coriaceis subopacis pellucido-punctulatis 5-nerviis, centrali nervo ad apicem ducto proximis alte supra medium ultimis subtilioribus sub medium ductis, petiolo glabro basi vaginante, pedunculo glabro petiolum paullo superante, amento densifloro folium fere duplo superante, rhachi pubescente, bractea ovario proxima ovato-subrotunda intus et dorso pubescente, staminibus 5–6, ovario glabro, stigmatibus 3. In Jamaica (Wulfschlaegel! in h. Monac.) Rami ramulique glabri parche lenticellosi. Limbi 0,06 longi, 0,02 lati, petioli 0,04 longi. (v.s.)"

A comparison of *Piper wulfschlaegelii* and *Enckea subpanduraeformis* shows the two to be alike except in shape of leaf, the former entire, the latter lobed. The general dimensions are about equal. It would seem therefore that *Enckea subpanduraeformis* might be a form of *Piper wullschlaegelii.* On the other hand, if we compare *P. wullschlaegelii* with *P. amalago,* it is practically impossible to differentiate between them except for the slightly narrower leaves of the former. *P. amalago* was described by LINNAEUS (**17**) as follows:

"Piper foliis lanceolato-ovatis quinquenerviis rugosis. Amalago."

Even from the more complete description given by C. DECANDOLLE (**8**), no other essential difference can be noted:

"*Piper amalago* Linn. foliis modice petiolatis, e basi ima aequilatera et acuta ovatis vel ovato-ellipticis, apice longiuscule acuminatis acumine acuto mucronulatoque, utrinque glabris, 5–7-nerviis, petiolo basi ima vaginante pedunculoque petiolum paullo superante

glabris; spica limbum aequante vel eo paullo breviore densiflora glabra, bracteae ovario proximae obovato-subrotundae glabrae vertice inflexo; staminibus 5–6; bacca ovata glabra. . . . ."

"Frutex ramulis glabris, spiciferis in sicco 1½ mm. crassis, collenchymate haud libriformi in fasciculos discretos disposito fasciculis intramedullaribus 1-seriatis canali vacuo nullo. Limbi in sicco membranacei, subpellucidi, creberrime pellucido-punctati, 9–12 cm. longi et 4–6 cm. lati; petioli superiores adulti usque ad 1 cm. longi. Pedunculi circiter 1½ cm. longi; rhachis glabra. Stamina rhachi inserta, antheris reniformibus. Bacca vix 1½ mm. longa, stigmatibus ovatis crassiusculis et brevibus coronata."

"Hab. in Jamaica: P. Browne, Swartz (in H. DC. et in H. Willd. n. 684), Sloane, Distin, Alexander (in Herb. Kew), Millspaugh n. 1943." (fig. 3*d*).

Another later recognized Jamaican species, *Piper nigrinodum*, collected near Troy (Haris 9075), has nearly the same characteristics as the species already named, as the following description will show (9):

"*Piper nigrinodum* C. DC. (n. sp. e sect. Enckea).—Foliis breviter petiolatis, ovatis, basi subaequilatera rotundatis, apice acuminatis acumine obtusiusculo, utrinque glabris, 5-nerviis petiolo basi ima vaginante; pedunculo petiolum fere duplo superante, glabro, spica folii limbum paullo superante, subdensiflora; bractea rotundata inferne dorso hirtella, basi late truncata, rhachi puberula; antheris rotundato-reniformibus, filamentis brevissimis; ovario obconico, glabro, apice stilo carnoso umbonato munito; stigmatibus brevissimis, glabris; bacca elliptica, glabra, apice stilo carnoso umbonata, subacuta."

"Black-jointer incolarum."

"Frutex 10 ped. altus. Ramuli levissime costulati nodique glabri, in sicco nigri; spiciferi 1 mm. crassi, in 2 mm. crassis collenchyma haud libriforme in fasciculos discretos dispositum, fasciculi intramedullares 1-seriati canalis vacuus nullus. Limbi in sicco membranacei, creberrime pellucido-punctulati, usque ad 7 cm. longi; et 38 mm. lati; petioli 5 mm. longi. Pedunculi 12 mm. longi; spicae bacciferae circiter 8 cm. longae. Stamina 4–5. Baccae fere 2 mm. longae."

"Hab. in Jamaica prope Troy, alt. 500 m., m. Nov. Fruct.: W. Harris 9075 (H. Berol.)." (fig. 3*e*).

Material believed to be representative of *Piper nigrinodum* collected by MAXON and KILLIP no. 1504, near Ipswich, St. Elizabeth, shows leaf sizes from 2×5.5 to 4×8 cm. A photograph in the Herbarium of the University of Illinois, made for the secretary of the Linnean Society from the type specimen of *P. amalago* in the British Museum at South Kensington, England, shows leaf variations between 2.5×6 cm. and 4×8.5 cm. This seems to warrant the conclusion that, so far as leaf size and shape are concerned, which are the only essential differences, *P. amalago* may be held to include *P. nigrinodum* and *P. wullschlaegelii*.

Piper amalago subpanduriforme, as shown by a few twigs and leaves in the University of Illinois Herbarium, taken from part of the original collection in the Vienna Natural History Museum, has the black stems and joints of the "Black-jointer," *P. nigrinodum*. This at least shows some relation within the group, whether it is important or not.

In 1825 HAMILTON (13) described a glabrous, 3–5-nerved Jamaican *Piper* under the name *P. celtidifolium*, apparently unaware that this name had been applied ten years before to a Venezuelan *Piper*. DIETRICH (10), however, recognizing the Venezuelan form as *P. celtidifolium*, called the Jamaican form *P. dubium*. HAMILTON'S description shows that his *P. celtidifolium* will readily fall within the *amalago* group:

"*Piper celtidifolium*.—Fol. 3–5-nerviis alternis oblique cordatis lanceolato-acutis margine tenuissime cartilagineis glaberrimis; spad. oppositifoliis. P. celtidifolium. Herb. Prof. Desv. Antilles. (s.v.)"

Another Jamaican specimen (March 1403 in Griseb. Herb.) has been referred to in URBAN'S *Symbolae Antillanae* (8) as *Piper richardianum*, but it is likely that on reexamination it may prove to be *P. amalago*, since the characteristics of the two species are quite similar, and MARCH'S specimen is the only "*Piper richardianum*" reported from Jamaica.

The Jamaican specimens of *Piper amalago*, *P. nigrinodum*, *P. wullschlaegelii*, *P. dubium*, and *P. amalago subpanduriforme* are described as glabrous, except for the rachis, which is pubescent. On the other hand is *P. medium*, which is pubescent to hairy on the petiole and the nerves on the lower side of the leaf, and has broader leaves with rarely or never an unguiculate base. *P. medium* was

named and described by JACQUIN in *Icones Plantarum Rariorum* (1: 2, t. 8. 1781–93). Since his description is very brief, the following description of *P. medium* as understood by C. DECANDOLLE is taken from his *Prodromus* (4).

P. medium (Jacq. ic. rar. v. 1. p. 2. t. 8.), foliis petiolatis ellipticolanceolatis vel ovato-lanceolatis apice acuminatis, acumine obtusiusculo mucronulato, inferioribus basi aequali cordatis super. basi. aequali rotundatis vel subattenuato-acutiusculis vel basi ima subcuneatis cuneatisve supra glabris subtus ad nervos puberulis vel glabratis siccis membranaceis subpellucidis subtilissime pellucidopunctatis 7-nerviis, nervis supra subprominulis subtus prominulis centrali ad apicem ducto proximis fere ad apicem sequentibus supra medium ductis infimis subtilioribus saepe obsoletis, petiolo basi ima vaginante hirtello dein glabrato, pedunculo glabro petiolum aequante, amento filiformi quam folium 1/3 breviore densifloro, rhachi puberula, bracteae ovario proximae obovatae dorso villosulae vertice inflexo nudo, stam. 4, filamentis antheras aequantibus, ovario glabro, stigmatibus 3 sessilibus, bacca glabra emersa ovoidea apice attenuata. . . . . Rami glabri, ramuli glabri. Limbi 0,11 longi, 0,05–0,06 lati, petioli, 0,008–0,01 longi. Amenta flor. 0,06 longa, 0,0015 crassa. (v.s.)" (fig. 3*f*).

The first knowledge of *Piper medium* dates from pre-Linnean times, when PLUKENETT (21) wrote of "*Piper frutex* americ. spica longa gracili" (fig. 3*g*), and SLOANE (22) wrote of "*Piper* longum arboreum altius, folio nervoso minore, spica graciliori & breviore." A little later (1756) BROWNE (1) wrote of "*P. frutescens* diffusum ramis flexilibus geniculatis, foliis ovatis ad petiolum leniter revolutis."

According to the unpublished notes of TRELEASE, made when he examined the specimens on which PLUKENETT based his description (Herb. Sloane Vol. 3. no. 109, South Kensington, England) and SLOANE his description (Herb. Sloane vol. 2. no. 79), the young twigs and petioles of these specimens are slightly velvety to hairy, and the leaves are much larger than the descriptions given above for *P. amalago*. BROWNE's type of leaf is more ovate than that of SLOANE, but the broader leaf and the pubescence let them fall under another group, of which *P. medium* is the type.

There is another important distinction between these two groups

from Jamaica. The leaves of *P. medium* seldom or never have an unguiculate base, while at the leaf base of *P. amalago subpanduriforme* in the Herbarium of the University of Illinois there is quite frequently a slight inrolling or unguiculation. This is to be seen on the leaves also of *P. nigrinodum* in the same herbarium. TRELEASE (**24**) shows that this is true also of *P. amalago* as commonly understood.

Because of this unguiculate base and because of the general characteristics of the plant, it seems almost certain that some of the Jamaican plants referred to *Piper unguiculatum* (**4**) have been misidentified with the similar but different South American species of the same name, the stems and leaves of which dry a light green color compared with the blackened stems and leaves of the Jamaican specimens observed. Also, *P. unguiculatum* has been reported only twice outside the South American continent. Once it was collected at the Botanical Garden of Trinidad off the coast of Venezuela and noted as a wild or escaped plant from the Botanical Garden there. Again it was cultivated as a decorative plant at Basse Terre on the Island of Guadeloupe. It is certain, therefore, that Jamaican plants referred to *P. unguiculatum* are merely *P. amalago*.

In the sense here used *Piper amalago* is represented in the following principal collections of the world (exclusively from Jamaica and the Caymans): near Port Antonio (Fredholm 3313, U.S. Nat. Herb.; Hitchcock, Field Museum): near Hope Tavern (Harris 6590, U.S. Nat. Herb., Urban's Herb., Kew): near Stanmore Hill (Harris 9972, U.S. Nat. Herb., Urban's Herb.): near Williams Ford (Millspaugh 1943, Field Museum, Urban's Herb.): near Troy (Harris 9075, N.Y. Bot. Gard., U.S. Nat. Herb., Kew (cotype)): near Potsdam Hill (Harris 9805, U.S. Nat. Herb., Urban's Herb.): near Yallahs Valley (Harris 6505, U.S. Nat. Herb., Urban's Herb.): on the road to Guava Ridge (Harris 8354, Urban's Herb.): at Hope Mines (Harris 8353, Urban's Herb.): near Mendeville (Britton 1027, N.Y. Bot. Gard., U.S. Nat. Herb.): near Green River (Harris 8342, Urban's Herb.): in Blue Mts. (O. Hansen, Copenhagen, Urban's Herb.): near Ginger River (D. S. Johnson 26, Field Museum): near Diabolo (Kew): no locality given (Lloyd 1094; Millspaugh 1299; Rothrock 224; Harris 6505, 8342, 8353, 9075, 9972, Field

Museum; Britton 341, Field Museum; Disdain at Kew (labeled *Enckea celtidifolium*); Nilson 178, Kew; Alexander, Kew; Balbis, Dahlem; Bertero (as *discolor-berteroanum* C. DC.)).

In contrast with this, *Piper medium* is represented only by the following: near Toms River (Thompson 8049, Urban's Herb.): no locality given (Schwartz in Herb. Vahl. [labeled as P. amalago]; McMurray 626, Herb. DC.).

These facts seem to justify the position taken by GRISEBACH when he held *Enckea subpanduraeformis* Miq. to be a form of *Piper amalago* L. They equally justify the conclusion that *P. wullschlaegelii*, which has been collected only twice, is to be considered as *P. amalago*. On this basis the *amalago* peppers of Jamaica, which are glabrous except for the spike rachis, are to be called *P. amalago* L., with the synonyms *P. wullschlaegelii* C. DC., *P. nigrinodum* C. DC., *P. richardianum* C. DC. (Jamaican forms only), *P. dubium* Diet., and *P. unguiculatum* Ruiz and Pav. (Jamaican forms only), and with *Enckea subpanduraeformis* Miq., a varietal form or monstrosity bearing the name *P. amalago subpanduriforme* (Miq.). Admitting *P. medium* tentatively to the Jamaican flora, we may note that it is represented only by the pubescent specimens previously mentioned, and by the two specimens in the Sloane Herbarium.

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ASPECTS OF THE MADEIRA FLORA

T. D. A. COCKERELL

In less than fifty years, Mr. CHARLES O. L. POWER has developed a garden at Quinta do Deão, Madeira Island, which contains a most remarkable collection of living woody plants that has been too much neglected by botanists.

When we consider any locality from a botanical standpoint, we may distinguish between the actual and possible flora. Thus, for example, a desert area may not have more than a small number of the existing plants which would grow there, but when we have enumerated these, there remain innumerable species which could not survive under the conditions found. As a broad proposition, this is commonplace and uninteresting; but the Madeira Islands afford such an extreme case of divergence between the indigenous and potential flora that they are worthy of study on this account.

The mean annual temperature at Funchal, according to LOWE, is 65°–67° F.; that of Porto Santo, observed by Mr. A. C. DE NORONHA, is a little higher. The climate is equable, without great extreme, but in the winter or early spring one may see snow on the high mountains above Funchal. The native flora is strictly Palaearctic, the few apparent exceptions probably representing types which formerly existed in Europe, but which are now extinct there. Nevertheless, Mr. POWER'S garden has an essentially tropical aspect, and there is no doubt that the lower levels on the island are suited for many kinds of tropical vegetation. What the limitations are we do not yet know, but plants which require extreme heat to ripen their seeds could not be perpetuated (unless vegetatively) in the wild state. Thus the date palm, which grows luxuriantly, fails to produce edible fruit.

A very good catalogue of the flora of the Madeira Islands was published at Funchal by C. A. DE MENEZES in 1914. He lists in all 951 species of flowering plants and vascular cryptogams. Of these, 111 are marked with two asterisks, as being widely cultivated forms, not properly belonging to the flora. No less than 154 others are known to be introduced species which have become established. This

leaves only 686 possibly native, and there is no doubt that many of these have been introduced during the long period of human occupation. In the case of *Eriobotrya japonica* (Thunb.) Lindl., the commonly cultivated and much appreciated loquat, the asterisks have been omitted by accident. It has been estimated that there are from 80 to 90 species of endemic flowering plants, and about 110 peculiar to Madeira and one or other of the Atlantic islands. The exact number of genuine endemics will not be known until further revisions are made, but it is certain that the number is quite large, perhaps not less than one-fifth of the really indigenous flora. The Azores (TRELEASE, 1897) have only 39 species of endemic flowering plants and vascular cryptogams, but their topography is less suitable for a large flora.

Enumerating the endemic plants of the Madeiras, we find two classes: those which closely resemble European species, and those which are quite distinct and isolated. The latter, mainly woody plants, represent the older flora, and, like the endemic snails, must have arrived far back in Tertiary time. The first of these groups includes such species as *Sambucus maderensis* Lowe, once considered a variety of *S. nigra; Sorbus maderensis* (Lowe) Dode, described as a variety of *S. aucuparia;* and *Ruscus* (? var. of *hypophyllum* L.) *lanceolatus* (Lowe). The second group, of which several species are well figured in *Die Vegetation der Erde*, IX, Bd. 1, consists of such as the following, if we include in it species peculiar to the Atlantic islands, but not necessarily to the Madeiras:

Pittosporum coriaceum Aiton.—Endemic, extinct, or nearly so. Species of *Pittosporum* occur in the European Oligocene and Miocene.

Visnea mocanera L. f.—Madeira and Canaries only.

Monizia edulis Lowe.—A remarkable umbellifer, also on the Selvage Islands.

Clethra arborea Aiton.—Endemic species of an American genus. *Clethra* also occurs (well preserved fruits) in Baltic amber, so it is not necessary to suppose that the ancestor of *C. arborea* came direct from America.

Heberdenia excelsa (Aiton) Banks.—Madeira and Canaries only. Often referred to *Ardisia,* of which there are several European Tertiary species.

Sideroxylon marmulano Lowe.—Endemic, now very rare. The genus occurs in the European Tertiary rocks.

Notelaea excelsa (Aiton) Webb.—Madeira, Canaries, and Azores only. SAPORTA described a species from the Pliocene.

Phoebe indica (L.) Pax., also called *Persea indica* (L.) Spr.—Madeira and Canaries only. The Azores have an endemic *Persea azorica* Seub., and the genus occurs in the European Miocene.

Apollonias barbusana (Cav.) W. & B., or *A. canariensis* (Willd.) Nees.—Madeira and Canaries only.

Ocotea foetens (Aiton) B. & H.—Madeiras and Canaries only.

Dracaena draco L.—Madeiras and Canaries only. SAPORTA described species, ascribed to this genus, from the Eocene and Oligocene of Europe. The genus is well represented in Africa today.

Thus we have preserved in the Atlantic islands remnants of the Tertiary flora of Europe, modified of course as to species.[1] The snails of the Madeiras show just the same sort of thing.

On the other hand, not only is the tropical or subtropical flora wholly absent from the islands (except as introduced), but many prominent Palaearctic genera are lacking, such as *Acer*, *Alnus*, *Betula*, *Carpinus*, *Cornus*, *Corylus*, *Fagus*, *Fraxinus*, *Pinus*, *Prunus*, *Quercus*, *Ribes*, *Tilia*, *Ulmus*, *Vitis*, etc. There are no palms or tree-ferns.

It is of course possible to postulate a considerable extinct flora, and to suppose that many species were destroyed in quite recent times by the burning of the forests or through the intensive cultivation of the mountain sides and valleys and the introduction of weeds. I myself noticed, in the vicinity of the Portella Pass, how the people burned over the *Ilex*-covered hillsides. One is fascinated by the thought that remarkable species may still lurk, nearly extinct, on steep cliffs or in deep valleys of the mountains.

Many years ago a deposit of fossil plants was found in the São Jorge Valley, Madeira, and in 1857 HEER published a list of 26 species, of which 18 were definitely determined. Seven were treated as new, and placed in the genera *Asplenium*, *Salix*, *Corylus*, *Ilex*,

[1] According to G. DEPAPE, the actual species *Ilex canariensis*, *Persea* or *Phoebe indica*, and *Oreodaphne* or *Ocotea foetens*, now living in Madeira, occur fossil in the Pliocene of the Rhone Valley. With these occur *Liriodendron tulipifera*, *Sassafras*, *Ginkgo*, *Torreya*, *Sequoia*, etc.

Pistacia, and *Phyllites* (*? Rhus*). One species was doubtfully referred to *Ulmus suberosa*. The flora was presumably not earlier than Pleistocene, but still of considerable interest, as it indicated several extinct species. LOWE, however, who knew the Madeira flora better than any one else, declared that the supposed new *Ilex* was *Vaccinium maderense*, the supposed *Ulmus* and the *Corylus* were leaflets of the native *Rubus*, the *Pistacia* was not of that genus, and so forth. Thus, as the matter stands, we are not certain that we know any extinct species. Unfortunately it is no longer possible to find any fossil plants at this place. Other similar remains were reported from Porto da Cruz, on the north shore of the island. I went there in search of them, but could find nothing recognizable.

There is a depth of 2400 fathoms between Madeira and the Canaries, of 2225 between Madeira and the African coast, of 2675 between Madeira and the Azores. The accumulated evidence of all sorts goes to show that the Madeiras are truly oceanic, and were never united with the mainland. WALLACE (Island Life, 2d. ed., 1892), in discussing the Azores, has gone rather fully into the question of transportation across the sea. J. Y. JOHNSON listed no less than 70 species of birds as visitors or stragglers to Madeira, and these must have been instrumental in bringing seeds. The birds in question are Palaearctic species, including some Mediterranean types. The trade winds blow southward from the direction of the Spanish peninsula, and the Canaries current has the same general direction. Thus floating objects might come from the west of Europe, or even across the Atlantic, but not from the south, and hardly from the African coast.

In Mr. POWER'S garden are 56 species of palms, 9 of cycads, 12 of tree-ferns, the last practically all grown from spores, except *Cyathea dealbata*. Most of the plants were grown from seed, as it is very difficult as a rule to import living plants. Mr. POWER not only gave me a list of the principal species, but took me around the garden, and I personally examined nearly all of them, and found them well developed and in good condition. Allowing for the favorable conditions of cultivation, it must be admitted that the soil and climate of the island are adapted for an amazing diversity of plants,

so that the insular nature of the actually native flora becomes more strikingly evident.

I have not undertaken to enumerate all the species in POWER'S collection, but only enough to bring out clearly the point of the argument. I have arranged them according to the region or continent of their origin:

1. AUSTRALIA.—*Alsophila australis* R. Br.; *A. excelsa* R. Br.; *Dicksonia antarctica* Labill.; *Macrozamia moorei* F. Muell.; *Livistona australis* Mart.; *Areca aliciae* W. Hill; *Araucaria bidwilli* Hook.; *Brassaia actinophylla* F. Muell.; *Castanospermum australe* A. Cunn. & Fraser; *Casuarina suberosa* Otto & Dietr.; *C. cunninghamiana* Miq.; *Doryanthes excelsa* Correa; *D. palmeri* W. Hill; *Dammara robusta* C. Moore; *Eucalyptus ficifolia* F. Muell.; *E. globulus* Labill.; *E. amygdalina* Labill.; *E. calophylla* R. Br.; *E. citriodora* Hook.; *E. colossea* F. Muell. (immense tree, from seed); *Ficus cunninghamii* Miq.; *Grevillea robusta* A. Cunn.; *Hymenosporum flavum* F. Muell.; *Lagunaria pattersonii* D. Don. (fine tree); *Randia fitzalani* F. Muell. (badly infested by the coccid *Saissetia hemisphaerica*, with much black fungus); *Syncarpia laurifolia* Tenore; *Sterculia diversifolia* G. Don.; *S. acerifolia* A. Cunn.; *S. rupestris* Benth. (little tree); *Macadamia ternifolia* F. Muell.; *Stenocarpus sinuatus* Endl.; *Buckinghamia* sp.; *Tecoma smithii* W. Wats.

2. NEW ZEALAND.—*Cyathea dealbata* Swartz; *C. medullaris* Swartz; *Dicksonia squarrosa* Swartz; *D. fibrosa* Col.; *Rhopalostylis sapida* (Soland.) H. Wendl. & Drude; *Cordyline australis* Hook. f.

3. PACIFIC ISLANDS.—*Howea belmoreana* (F. Muell.) Becc. (Ld. Howe I.); *H. forsteriana* (F. Muell.) Becc. (Ld. Howe I.); *Hedyscepe canterburyana* (F. Muell.) H. Wendl. & Drude (Ld. Howe I.); *Veitchia joannis* H. Wendl. (Fiji); *Pritchardia martii* H. Wendl.; *P. pacifica* Seem. (Fiji); *Rhopalostylis baueri* (Hook. f.) H. Wendl. & Drude (Norfolk and Chatham Is.); *Araucaria excelsa* R. Bar. (Norfolk I.); *A. cookii* R. Br. (New Caledonia); *Artocarpus cannoni* Van Houtte (Society Is.); *Ficus parcelli* Veitch (with varying leaves); *Hibiscus tricuspis* Banks (tree); *Pothos aureus* Linden (Solomon Is.).

4. CHINA AND JAPAN.—*Trachycarpus excelsus* (Thunb.) H. Wendl.; *Rhapis flabelliformis* L'Her.; *Bambusa aurea* Sieb.; *Camphora camphora* (L.) Karst.; *Diospyros kaki* L. F.; *Gleditschia sinensis*

Lam.; *Trachelospermum jasminoides* (Lindl.) Lem.; *Ginkgo biloba* L.; *Osmanthus fragrans* (Thunb.) Lour.; *Paulownia imperialis* Sieb. & Zucc.; *Musa coccinea* Andr.; *Wistaria chinensis* D. C.

5. MALAYA.—*Cycas circinalis* L.; *Arenga saccharifera* Labill.; *Calamus asperrimus* Blume (small); *Caryota rumphiana* Mart.; *C. blancoi* Hort.; *C. mitis* Lour.; *Livistona altissima* Zoll.; *L. hoogendorpii* Andre; *Nenga wendlandiana* Scheff; *Eugenia pendula* D. C.; *Bombax malabaricum* D. C.; *Broussonetia papyrifera* Vent.; *Casuarina equisetifolia* L.; *Michelia champaca* L.

6. INDIAN REGION.—*Phoenix rupicola* T. Anders.; *P. roebelenii* O'Brien; *Caryota urens* L.; *Oncosperma fasciculatum* Thw.; *Wallichia caryotoides* Roxb.; *Alpinia nutans* Rose.; *Bauhinia tomentosa* L.; *B. purpurea* L. (fine tree); *Beaumontia grandiflora* Wall.; *Caesalpinia sappan* L.; *Cinnamomum cinnamomum* (L.) Ckll.; *Eugenia jambos* L.; *E. malaccensis* L.; *Ficus elastica* Roxb.; *F. religiosa* L. (from seed); *F. benghalensis* L.; *Saraca indica* L.; *Lagerstroemia indica* L.; *L. flos-reginae* Retz.; *Pandanus furcatus* Roxb. (from seed); *Melia azedarach* L.; *Solanum auriculatum* Aiton; *Tamarindus indica* L.; *Murraya exotica* L.; *Quisqualis indica* L.; *Thunbergia grandiflora* Roxb.; *T. mysarensis* T. Anders.; *Lonicera hildebrandiana* Coll. & Hemsley.

7. ISLANDS OF INDIAN OCEAN.—*Latania commersonii* Gmel. (as *L. borbonica*, and perhaps was really *Livistona chinensis*); *L. rubra* Jacq. (said to be *commersonii*); *Hyophorbe amaricaulis* Mart.; *H. verschaffelti* H. Wendl.

8. MADAGASCAR.—*Chrysalidocarpus lutescens* H. Wendl.; *Dombeya wallichii* (Lindl.) B. & H.; *Buddleia madagascariensis* Lem.; *Cyperus alternifolius* L.; *Ravenala madagascariensis* J. F. Gmel.; *Pandanus utilis* Bory; *Stephanotis floribunda* Brougn.; *Delonix regia* (Bojer) Raf. (has never flowered).

9. AFRICA.—*Phoenix reclinata* Jacq.; *Corypha umbraculifera* L.; *Blighia sapida* Kon.; *Euphorbia candelabrum* Trem.; *Erythrina tomentosa* R. Br.; *Kigelia pinnata* D. C.; *Plumbago capensis* Thunb.; *Schotia speciosa* Jacq.; *Strelitzia reginae* Banks; *Spathodea campanulata* Beauv.; *Asparagus sprengeri* Regel; *Encephalartos lehmanni* Lehm.; *E. cycadifolius* var. *friderici-guilielmi* (Lehm.) Rod.; *E. altensteinii* Lehm.; *E. villosus* Lam.; *E. caffer* Miq.

10. EUROPE AND MEDITERRANEAN REGION.—*Phoenix dactyli-*

fera L.; *Cyperus papyrus* L.; *Buxus sempervirens* L.; *Fagus sylvatica* var. *purpurea* Aiton.

11. CANARY IS.—*Phoenix canariensis* Chab.

12. NORTH AMERICA.—*Magnolia grandiflora* L. (two, very fine); *Bulneria florida* (L.) Kearney; *Serenoa serrulata* (Michx.) Hook. f.; *Washingtonia filifera* (Linden) H. Wendl.; *Sabal glabra* (Mill.) Sarg.

13. MEXICO AND CENTRAL AMERICA.—*Acanthorrhiza mocinni* (H. B. K.) B. & H.; *Chamaedorea* sp.; *Erythea edulis* (H. Wendl.) S. Wats.; *E. armata* S. Wats.; *Washingtonia sonorae* S. Wats.; *Ageratum mexicanum* Sims.; *Beaucarnea recurvata* Lem.; *Bignonia cherere* Lindl.; *Datura suaveolens* Poir.

14. WEST INDIES.—*Oreodoxa oleracea* Mart.; *Roystonea regia* (H. B. K.) O. F. Cook; *Sabal blackburniana* Glazebrook (slow growing); *Thrinax parviflora* Sw.; *Erythrina speciosa* Andr.; *Hibiscus elatus* Sw. (tree, from seed); *Theophrasta imperialis* Linden.

15. SOUTH AMERICA.—*Cocos plumosa* Hook.; *C. weddelliana* H. Wendl.;[2] *Diplothemium maritimum* Mart.; *Jubaea spectabilis* H. B. K.; *Trithrinax brasiliensis* Mart.; *Brownea coccinea* Jacq.; *B. grandiceps* Jacq.; *B. ariza* Benth.; *Bombax erianthus* Cav. (said to be *Eriodendron leiantherum* D. C.); *Bignonia purpurea* Lodd.; *Bougainvillea glabra* Choisy; *B. spectabilis* Willd.; *B. spectabilis* var. *lateritia* Lem.; *Crescentia cujete* L. (small, from seed); *Cestrum foetidissimum* Jacq. (*nocturnum* L. is the prior name); *Erythrina crista-galli* L.; *Eugenia brasiliensis* Lam.; *Hura crepitans* L.; *Calliandra tweedii* Benth. (as *Inga pulcherrima* Cerv.); *Jacaranda ovalifolia* R. Br.; *Schinus molle* L.; *Parmentiera cereifera* Seem.; *Swietenia mahagoni* Jacq. (small tree); *Solandra grandiflora* Sm.; *Mandevilla suaveolens* Lindl.; *Phytolacca dioica* L.; *Thevetia neriifolia* Juss.; *Streptesolen jamesonii* Miers. (this fine ornamental plant was sent to Madeira from Kew many years ago, and is now seen in gardens everywhere); *Monstera deliciosa* Liebm.

The following conclusions appear to be justified:

1. The Madeira Islands are "oceanic," and have received their indigenous flora from across the water, floating or carried by birds.

2. The means of transport are still in operation, and there are

[2] *Cocos nucifera* L. was in the collection, but it died. Madeira is not tropical enough for the coconut.

many indigenous plants which are unmodified, and others which are so little altered that authors have been divided in the matter of according them specific rank.

3. There are many introduced plants, however, and in the case of such species as *Portulaca oleracea* L., *Papaver rhoeas* L., *Trifolium repens* L., *Anagallis arvensis* L., etc., assumed by MANEZES to be native, it is impossible to be sure whether they were brought by man or came otherwise.

4. There is an ancient flora of mainly woody plants, which represents in modified form the Tertiary flora of Europe. This series of plants, although now appearing to have certain tropical (in one case American) affinities, was not derived from the tropics, but from the Palaearctic region, the case being parallel with that of the snails.

5. We may presume that part of the insular flora has become extinct; thus the dragon-tree (*Dracaena*) has entirely disappeared from Porto Santo, where it was once a conspicuous feature. The fossil plants, however, give as yet no satisfactory evidence.

6. The ease with which plants of many kinds, tropical and subtropical, can be grown in Madeira, indicates that the island is suited to a flora very different from that which actually occupied it. It affords additional support to the view that even in Tertiary times there was no immigration from tropical Africa, or from across the Atlantic. The means of transport were much the same then as now, and apparently there never was a current setting from the south.

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NOTES ON THE STRUCTURE OF PENNSYLVANIAN PLANTS FROM ILLINOIS. II

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(WITH PLATE VI AND SEVEN FIGURES)

The following notes are based on thin sections of coal balls, collected by Dr. A. C. Noé or by the writer from the Pennsylvanian of Illinois, and are presented in three parts.

1. Practically nothing is known concerning the structure of the leaves of *Calamites* known as *Annularia,* although they are not uncommonly found as impressions. Occurring very abundantly in a series of preparations are sections of leaves or bracts which are readily identified as Calamitean. The cross-section shown in fig. 1 is slightly crescent-shaped, and is expanded laterally to form a lamina. On the concave side is a median ridge which marks the position of the single vascular bundle, toward which the edges of the lamina are sometimes slightly pointed.

The cells of the epidermis are elongated toward the extremities of the organ. Those on the convex surface are generally larger and are always covered with a thick cuticle, which in some instances is equal to half the diameter of the epidermal cell. The cuticle is less in amount on the concave surface, although well developed opposite the vascular bundle.

The single median vascular bundle is situated very near the adaxial surface. Surrounding the vascular tissue is the bundle sheath of large cells, often somewhat irregular and occasionally more than one cell in thickness. These cells of the sheath above and below the bundle invariably have that dark content which gave rise to the term "melasmatic layer" (3), but usually this cell content is less in amount or even absent in the cells of the sheath lateral to the vascular bundle.

The bundle itself is composed of a circular group of spirally thickened tracheids (fig. 2), about seven or eight in number and of very small caliber, surrounded by a few irregular rows of thin-walled

elongated cells, slightly larger in diameter, which no doubt include what phloem is present. In longitudinal section it is apparent that the tracheids do not always constitute a solid strand, but are sometimes separated by cells with unthickened walls.

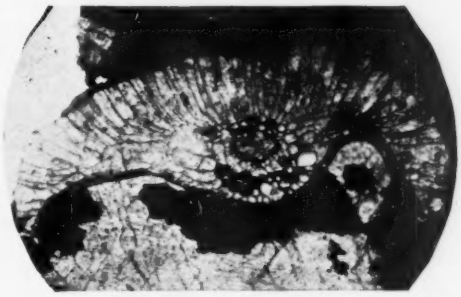

FIG. 1.—Transverse section of leaf or bract of *Calamites;* ×45.

There appears to be no fibrous or mechanical strand as described in certain Calamitean leaves of the *Asterophyllites* type (5). The elongated columnar cells, which are very similar in appearance to the palisade tissue of modern foliage leaves, constitute most of the tissue outside the bundle sheath. They are absent and adaxial to the bundle, however, and are modified laterally to it, where the cells are of larger diameter and approximately isodiametric. A longitudinal section (fig. 3) passing to one side of the vascular bundle shows the large intercellular spaces separating the parenchyma cells of the lamina.

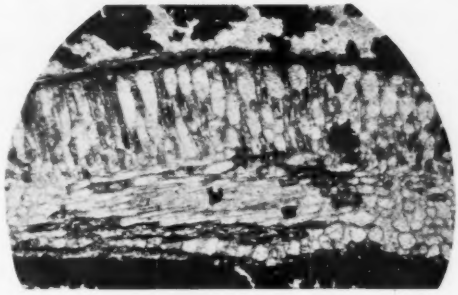

FIG. 2.—Longitudinal section cutting obliquely through vascular bundle, showing spiral thickenings of tracheids; ×45.

Positive identification of stomata is lacking; certainly they were absent on the convex surface. The evidence, however, points very strongly to the occurrence of stomata on the adaxial surface on either side of the midvein.

A longitudinal section parallel with the lamina measures about 1.6 mm. in width. The actual width as seen in transverse section is

about 2.6 mm. A vertical section through the region of the median vein measures about 0.63 mm. It is impossible to give an estimate of the length, as the longitudinal sections of several millimeters gave no indication of either extremity. Nothing is known, therefore, concerning the attachment of this organ to an axis.

RENAULT (4) figured a very similar transverse section which agrees well in size and general features with these specimens, but his illustrations give no details of the bundle. He thought that his section might well be that of a sterile bract of *Bruckmannia grand'euryi*, a *Calamostachys*.

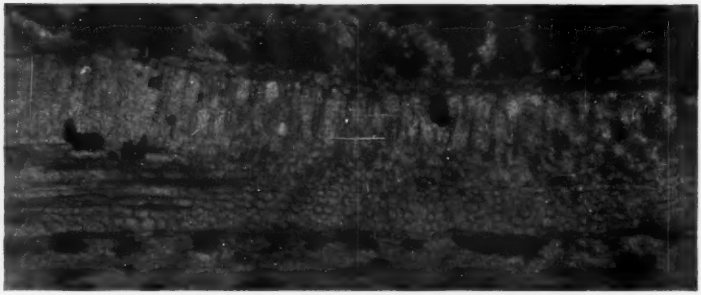

FIG. 3.—Longitudinal section to one side of vascular tissue showing arrangement of parenchyma tissue of lamina; ×45.

LADY ISABEL BROWNE (1), in a note without figures, described the sterile bracts of *Palaeostachys gracilis* Ren. Her description in many ways is similar to the one just given. She especially mentions the position of the vascular bundle as being near the adaxial surface. The measurements given in her note are smaller than those given here.

More recently CARPENTIER (2) has described a section which seems to coincide with the description given here in most details. He identified his specimen as the leaf or bract of *Calamites*. There is reason for referring these specimens to the leaves of *Calamites* of the *Annularia* type. A close comparison with the anatomy of the leaves of the *Asterophyllites* type as described by THOMAS shows an extraordinarily close agreement with certain of his types, not only in general appearance, but in most details. The dimensions of the sections

here described compare favorably with the size of impressions of species of *Annularia*, and the numerous transverse sections would seem to indicate an organ with little gradation in width, as the whole series is remarkably uniform in width and thickness. The longitudinal sections show no variation of size or structure. It must be remembered, however, that no indication of attachment was found in either transverse or longitudinal sections, so that the question must continue to remain open.

2. A petrified stem of *Lepidodendron* was collected from the McLeansboro formation (fig. 11). The specimen when found was some 12 cm. long, with a diameter of about 2.5 cm. It was entirely decorticated, with every indication that an unknown amount of secondary wood had been lost before petrifaction occurred. The preservation is exceptionally good.

The primary wood has a thickness of about twelve cells, which are rather uniform in size, an average cell measuring 0.126 by 0.180 mm., which is slightly larger than an average cell of secondary wood. The primary wood does not now form a continuous cylinder, but is more or less broken into groups which give the appearance superficially of being individual bundles. The stem has been subjected to considerable pressure, as shearing of the secondary wood shows, so that there is little doubt but that the primary wood originally consisted of an unbroken cylinder, which is indicated in some sections by a nearly complete ring.

The pith cavity is entirely destitute of cellular tissue, whether due to loss before petrifaction or whether normally absent in a stem of this size cannot be determined. Numerous leaf traces arise from the protoxylem on the outer face of the primary wood, and follow a horizontal course through the secondary wood. The rays are usually one cell in width, and frequently contain elements with spiral or scalariform thickenings.

Longitudinal sections show the usual spiral markings of the exarch protoxylem, and the scalariform thickening on both radial and tangential walls of the metaxylem and secondary wood.

Stigmaria is not uncommon in the Illinois coal balls. In transverse section (figs. 8, 9) the tracheids are almost entirely radially arranged, with no sharp distinction between primary and secondary

wood. The smallest tracheids with spiral markings are next to the pith cavity.

The woody cylinder is more or less divided into bundles by the primary rays. Secondary rays are numerous and are usually one cell in width. A large proportion of the secondary rays contain elongated elements with spiral or scalariform thickening. With the exception of the protoxylem, all the tracheids have scalariform markings on both radial and tangential walls. The last formed cells of the secondary

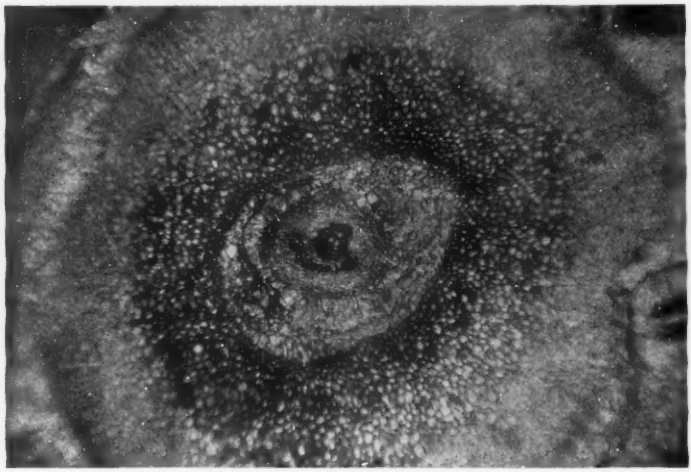

FIG. 4.—Transverse section of "rootlet" of *Stigmaria ficoides;* all tissues shown.

wood are distinctly smaller than the others, and in many cases are scarcely radial. This has been noticed frequently in British specimens of *Stigmaria.*

The tissue immediately surrounding the xylem is not well preserved in these sections. There is the usual periderm formation, exterior to which is the parenchymatous region of the outer cortex.

As is usually true, the stigmarian appendages, commonly called "rootlets," are the most common fossils. In some instances all the tissues of the appendages are well preserved (fig. 4), but in the usual state of petrifaction the middle cortex is entirely lost, as are also the delicate cells immediately surrounding the xylem of the stele.

The xylem of the stele is in connection with the innermost tracheids of the stigmarian axis, and follows a principal ray outward. A characteristic appearance of an outgoing rootlet trace is shown in the tangential section of *Stigmaria* (fig. 10). The xylem of the "rootlet" is more or less triangular in transverse section, with the protoxylem at one apex. The stele is therefore monarch. Many of these stigmarian appendages have developed secondary wood (fig. 5).

It appears that the structure of the axis and "rootlets" of these specimens is that which is described for *Stigmaria ficoides*, recogniz-

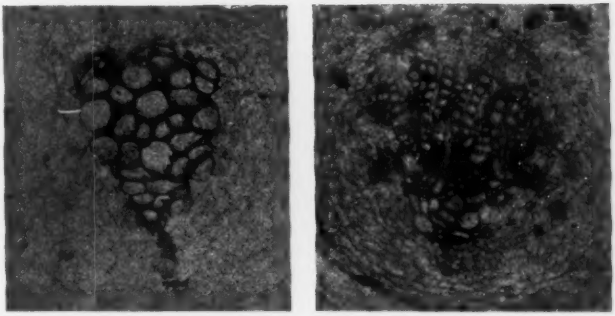

FIG. 5.—Transverse sections of stele of a *Stigmaria* appendage showing single protoxylem point and development of secondary wood.

ing the probability that the rather large variation of forms now included in this species may eventually be separated specifically.

3. Isolated *Psaronius* rootlets are commonly found in Illinois petrifactions. A small *Psaronius* stem is too disorganized to permit an accurate description, although it is obvious that certain of the isolated rootlets belong to quite another species than that of the stem.

The steles of the rootlets have the usual radial arrangement, with the smallest tracheids with spiral thickenings at the extremities of the arms. The larger tracheids are scalariform. There is an unusually small number of protoxylem points. The larger rootlets are pentarch; the smaller ones are often tetrarch or even triarch. The diameter of the larger rootlets is about 4.6 mm., the stele of which is about 1.2 mm. in diameter.

In some instances the phloem is well preserved, as shown in fig. 6, in which the stele is tetrarch, with the well preserved phloem alternating with the four arms of the xylem and surrounded by the endodermis. The striking lacunar cortex is often preserved with great exactness. Fig. 7 shows a portion of the cortex. Exterior to the

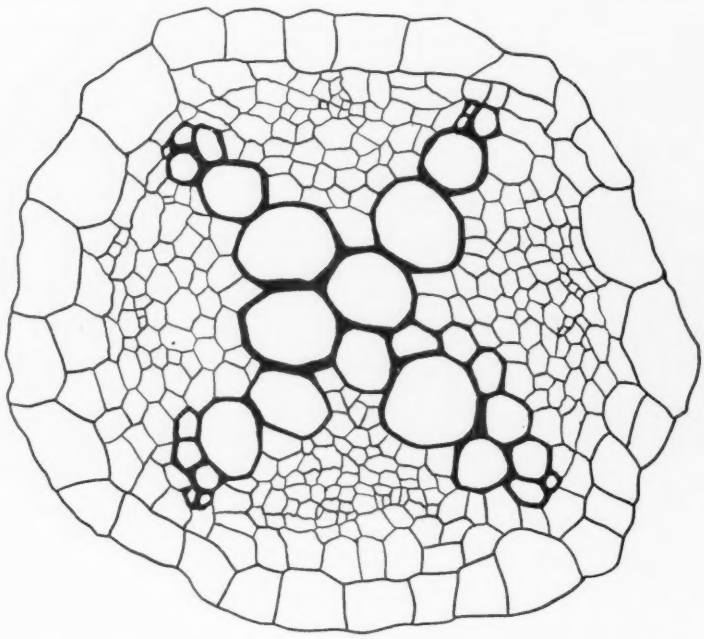

FIG. 6.—Camera lucida drawing of stele of *Psaronius* rootlet showing tetrarch stele; ×135.

lacunar tissue is a narrow zone of heavy-walled fibrous cells, two or three cells in width. Exterior to this mechanical tissue is a zone of parenchymatous tissue bounded in some instances by an epidermis. In most of the rootlets both the lacunar inner cortex and the parenchymatous outer zone were more or less destroyed before petrifaction.

No hairs were found attached to the larger rootlets with the epidermis preserved. These were probably free outer rootlets. In the

smaller ones the parenchymatous layer external to the mechanical tissue is lacking, a condition usually true of the inner root zone of *Psaronius*, where the sclerenchyma layer is the limiting tissue except

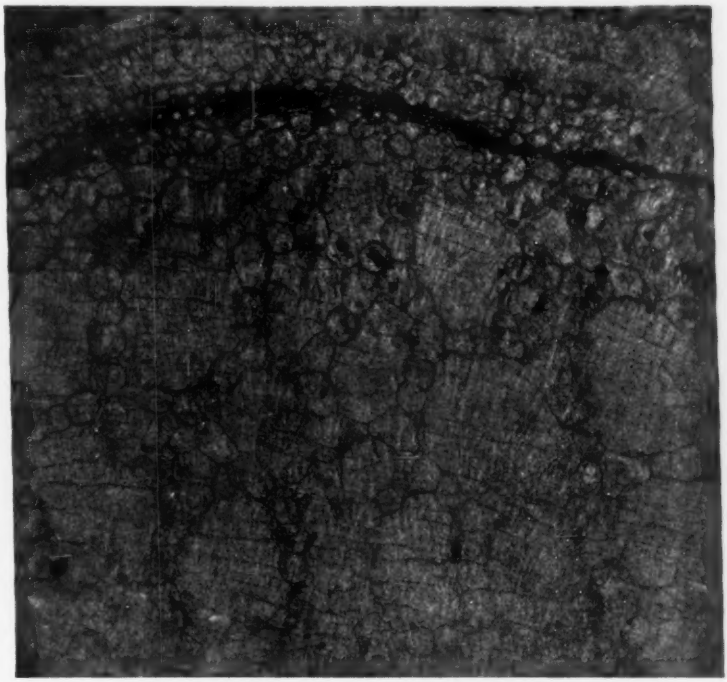

FIG. 7.—Transverse section of *Psaronius* rootlet showing lacunar cortex, narrow zone of mechanical tissue, and outer parenchymatous zone; ×55.

where the cells have elongated to form the filamentous interstitial tissue.

This investigation was initiated while the writer was a National Research Fellow in the Biological Sciences, and he wishes to express his great appreciation of the opportunity afforded by the financial assistance of the National Research Council.

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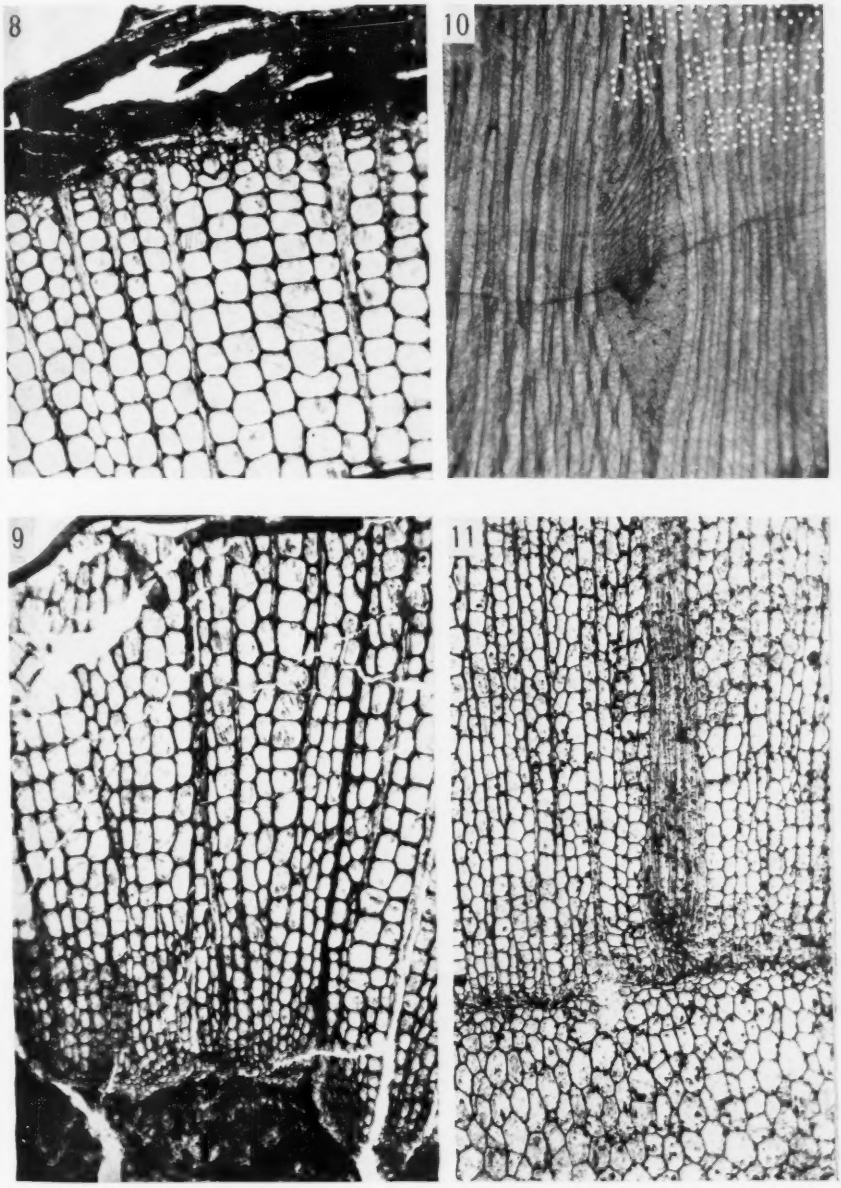
EXPLANATION OF PLATE VI

FIG. 8.—Transverse section of outer portion of stele of *Stigmaria ficoides:* latest formed tracheids are smaller and scarcely radial; ×32.

FIG. 9.—Tangential section of stele of *S. ficoides* showing an outgoing "rootlet" trace; ×16.

FIG. 10.—Transverse section of inner portion of stele of *S. ficoides;* ×27.

FIG. 11.—Transverse section of portion of stem of *Lepidodendron* showing primary and secondary wood; ×30.



HOSKINS on PENNSYLVANIAN PLANTS

NORTHERN ASPECT AND PHENOLOGY OF TALLAHASSEE RED HILLS FLORA

HERMAN KURZ

(WITH TWO FIGURES)

Northern disjuncts

To the average northern botanist, Florida is a peninsula projecting southward from the southeastern United States, where sand, swamps, lakes, sunshine, everblooming and tropical or subtropical plants are the rule. Few realize that topographically and geologically middle northern Florida is but an extension of Alabama and Georgia. A generalized map (fig. 1) after HARPER (1)[1] shows the most important features of these geographic regions in the form of a taxonomic key. A portion follows:

Soil largely red clay; topography rather hilly
  Streams common
    Limestone outcrops frequent; caves and natural bridges present.....Marianna Red Lands
    Limestone impure, cropping out only on bluffs; no caves.....Apalachicola River bluffs
    No rock outcrops.....Knox Hill Country
  Streams scarce
    No lakes.....Holmes Valley
    Lakes and ponds common.....Tallahassee Red Hills

The Knox Hill Country and Holmes Valley will not be discussed here. The most marked features of the Marianna Red Lands, the Apalachicola River Bluffs, and the Tallahassee Red Hills are the relatively rugged red clay hills. Their altitude is usually less than 300 feet above sea level, but they are frequently steep. The relatively undisturbed places contain mesophytic climax forests of magnolia, beech, maple, sweet gum, elm, ash, oak, hickory, basswood, tulip tree, hackberry, black cherry, mulberry, spruce pine,

[1] See the same paper for the geology, topography, soil, vegetation, and citations to older work.

and others. Several species of pines and oaks dominate the areas in the process of reforestation. These hilly regions are surrounded either by gently rolling dry, sterile, sand hills with long leaf pine and species of scrub oaks, or by waterlogged flatwoods, with long

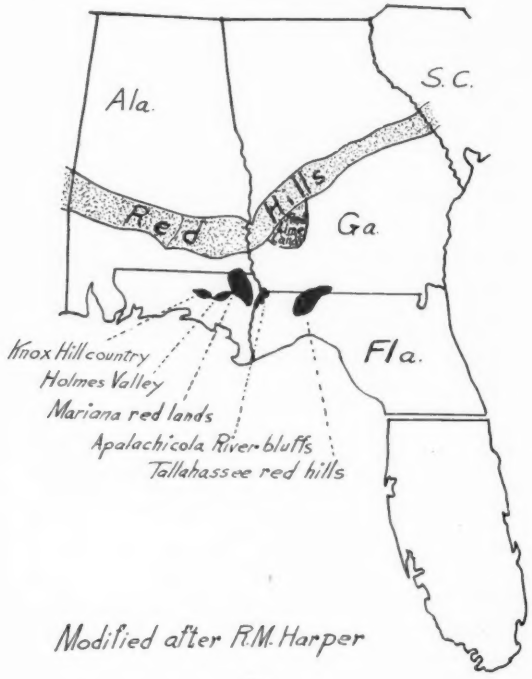


FIG. 1

leaf pine, wire grass, and various ericads, sarracenias, orchids, and so forth. This monotony is often broken by lakes, ponds, or gum, cypress, and bay swamps. Essentially, then, the three regions in question may be considered as hilly "islands" of rich loam or humus soils dominated by hardwood or pine-oak forests, and surrounded by an "ocean" of rolling sandy country or water-logged flatwoods.

That a number of northern herbs reach their southernmost limits in the rich and cool forests of the Marianna Red Lands and Apalachicola River Bluffs is well known. Naturally their range is there-

fore extended to Florida in SMALL'S *Flora of the Southeastern United States* and other books, but it should be emphasized that up to the present time these plants as a class have been known to occur only in the two very local areas of northern Florida just mentioned, where they appear again as northern disjuncts, after having skipped the scrub oak–pine lands and flatwoods of southern Alabama and Georgia.

The Tallahassee Red Hills, with their cool, rich mesophytic forests, form a third island suitable for a number of hitherto unreported northern disjuncts. A list follows:

Arisaema triphyllum[2]
Muricauda dracontium
Uvularia perfoliata
Oakesiella floridana
Salomonia biflora
Trillium underwoodii
Corallorhiza wisteriana
Ranunculus palmatus
Thalictrum purpurascens
Sanguinaria canadensis
Polygala polygama
Sanicula marylandica
Spigelia marylandica
Phlox pilosa (probably)
Penststemon hirsutus
Pedicularis canadensis
Hexastylis callifolia
Senecio aureus
Senecio obovatus

Most of these are found northward as far as New England and Canada. A few, like *Trillium underwoodii*, *Phlox pilosa*, *Oakesiella floridana*, and *Hexastylis callifolia*, suggest the north by virtue of their more northern close relatives. Besides these, *Monotropa uniflora*, *Epifagus virginiana*, *Conopholis americana*, and *Antennaria plantaginifolia*, also reported by Miss GANO (**2**), might be mentioned.

BRADFORD TORREY (**3**) states that "ground flowers were very little in evidence" around Tallahassee in spring. As most of the species are rare, naturally he missed them. While some habitats nearby do not belong to the Red Hills proper, they contain an additional number of northern or semi-northern ground flowers. Notable ones are *Lupinus nuttallii* (not very different from *L. perennis*), *Amsonia ciliata*, and *Phlox floridana* of the xerophytic sterile sands; *Sarracenia purpurea*, *Limodorum tuberosum*, *Pogonia ophioglossoides*,

[2] All species were classified according to SMALL'S *Flora of the Southeastern United States*.

P. divaricata, Ibidium cernuum, Atamasco atamasco, Viola lanceolata, and *V. primulifolia; Kalmia latifolia* along certain streams; and *Iris carolina* and *Amsonia amsonia* in certain marshes. This group, while not so restricted as the list given for the Red Hills, nevertheless serves to accentuate the northern aspect of the region as a whole. The northern aspect is still further reinforced by the data of the following phenological study. Out of a total of 319 flowering plants, naturals[3] and ruderals,[4] observed, about three-fourths extend northward at least to Virginia; and of these about one-half reach as far as Minnesota, Illinois, Ohio, New Jersey, New York, New England, and northeastern Canada. Finally, to offset those northern flowers actually missing, we find, especially in the "scrub oaks" and flatwoods, southern species of lupines, orchids, pinguiculas, sarracenias, sundews, composites, and others.

Phenology

Nothing definite has appeared about the spring flowering season of the Tallahassee vicinity. Miss GANO does say that "There is no vernal flora, nor can a definite flowering season be set, but there is overlapping and irregularity in the prolongation of the blooming season, conditions related to the spring drought and to the extended growing season due to climatic causes." This statement does not fit the facts exactly, however, for the leafless deciduous trees and shrubs and the many dead autumn herbs in chilly January suggest at once a lull in vegetational activity, which, while not so extreme, is yet comparable with the winter conditions of the north.

With the purpose of acquiring some information about the "vernal flora," "overlap," "irregularity," and "prolongation of growing season," therefore, blooming dates for 319 species growing within 25 miles of Tallahassee were taken. Such a radius of course takes in a variety of habitats not typical of the Red Hills. Beginning with January 1 and ending May 15, 1925, one or more trips a week were made into the field in order to catch the earliest or nearly earliest blooming dates. The total number of new naturals and ruderals

[3] A word adapted by the writer for wild plants characteristic of relatively undisturbed areas.

[4] Plants, native and introduced, of old fields, waysides, etc.

are plotted separately on the graph, each species being counted only once. It is now realized that duration of blooming periods of a representative number of species should have been recorded. However, since the dates have at least been partially checked, it is felt that even this preliminary work can be relied upon for a general idea of the seasonal periodicity. Mr. W. H. MARKHAM, the local United

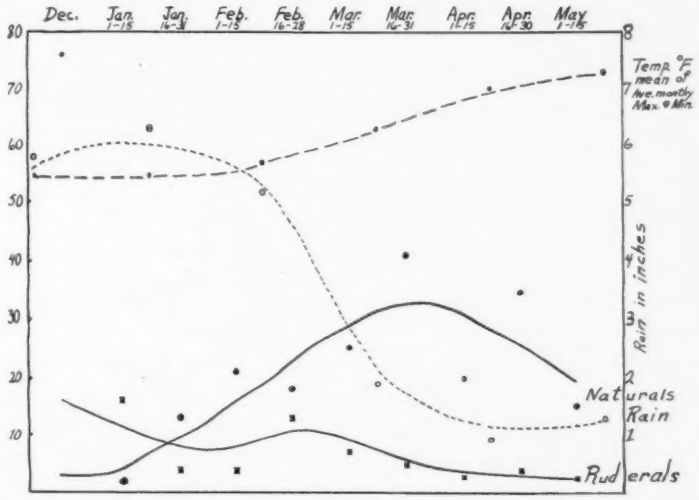


FIG. 2

States Weather Bureau observer, furnished the temperature and rainfall data. Additional meteorological data were not available (*fig. 2*).

In the autumn of 1925 a number of trips were made in order to ascertain approximately the duration of the autumn bloomers. The following was found:

	OCTOBER AND EARLY NOVEMBER	DECEMBER
Naturals	31	4
Ruderals	21	11

Among the few naturals continuing into December are *Hamamelis virginiana*, *Dasystephana tenuifolia*, and *Aster* spp. *Monotropa uniflora* blooms in October and early November, whereas its time for Long

Island and Illinois is in July and August. At St. Petersburg it is reported to bloom at Christmas, so that this is an example of one of the summer bloomers of the north that flower progressively later southward rather than earlier, as do most of the typical spring bloomers common to both north Florida and the northern states. Examples of autumn ruderals lagging occasionally over into December and even January are *Solanum nigrum*, *Onagra biennis*, *Ambrosia artemisiifolia*, *Helenium tenuifolia*, *Sida acuta*, *S. rhombifolia*, *Malvastrum americanum*, *Nothoscordum bivalve*, *Oxalis stricta*, etc., the last two continuing more or less throughout the winter. Most important, however, in dovetailing late fall with early spring[5] flowering are such winter annuals or biennials as *Sitilias caroliniana*, *Gnaphalium purpureum*, *Sonchus asper*, *Argemone mexicana*, *Erigeron philadelphicus*, *Lamium amplexicaule*, *Veronica arvensis*, *V. agrestis*, *V. peregrina*, *Houstonia minor*, *Alsine media*, *Draba brachycarpa*, *Coronopus didymus*, and others. About the beginning of February these are replaced or supplemented by such species as *Linaria canadensis*, *Medicago arabica*, *Specularia perfoliata*, *Plantago virginica*, *Spermolepis divaricatus*, *Chaerophyllum tainturieri*, and others.

These lists, while not by any means exhaustive, will suffice to demonstrate the part these common ruderals play in the overlap of flowering. While they are hardy as a class, their activity may nevertheless be checked or delayed temporarily.

To them, also, may be attributed most of the irregularity and everblooming spoken of by Miss GANO. Excepting *Polygala lutea*, *P. nana*, and a few asters, no naturals have been noticed blooming all winter, so that everblooming by this class is negligible. In January the first naturals appear. From then on they flower in increasing numbers until some time in March, after which there is a gradual decline. They exhibit therefore a periodicity which, while not so abrupt (although earlier than in the north), is yet rather definite. As expected, even the blooming of naturals may be delayed during relatively severe winters. During the winter of 1925–26, when the temperature averaged about 6° F. lower than in 1924–25, the class as a whole flowered about two weeks later, but there was no irregularity.

[5] Spring in terms of flowering activity of naturals begins here in January.

Whether or not the Tallahassee vicinity can boast of a vernal flora depends on the rigidity of definition. However, the foregoing data ought to prove that there is a vernal flora, at least in spirit, if not in letter.

The writer owes much to Dr. R. M. HARPER for his suggestions and criticisms, and for his aid in the location of a number of stations for rare species and their identification. Thanks are also due to Dr. RAYMOND BELLAMY for aid in field observation.

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SOME NEW AND LITTLE KNOWN SPECIES OF *TRACHELOMONES* FROM NORTH MANCHURIA, CHINA

B. W. SKVORTZOW

(WITH PLATE VII)

The summer of 1924 was spent by the writer at the biological station of the Manchuria Research Society at Harbin, who during that time studied the algae of the district surrounding the station. This paper presents a list of the new forms of *Trachelomones* EHRENBERG discovered in marshes, ponds, and lakes of the Sungary River valley, and also descriptions of some little known species from Europe and other countries.

TRACHELOMONES TUBEROSA Skv., Jour. Asiatic Soc. Shanghai **4**:53. 1919; PASCHER, Archiv Protistenkunde **48**:504. 1924.—Shell elongated, variable in shape, contracted at both ends, brown, 28 by 13 μ; neck 4.5 μ broad; chromatophores numerous; stigma distinct; cilia 1.5–2 times longer than shell.—Fig. 1.

In marshes near Harbin.

TRACHELOMONES TUBEROSA **conspersa,** var. nov.—Shell brown and covered with knobs, 33.3 by 18.5 μ; chromatophores 8; stigma distinct; cilia 1.5 times longer than shell.—Fig. 2.

In marshes near Harbin.

Trachelomones cucurbita, sp. nov.; *T. helvetica* Lemm. var. *hispida* Skv., Jour. Asiatic. Soc. Shanghai **4**:72. 1919.—Shell brown, covered with sharp pointed spines, elongated, contracted at both ends and rounded at the end, 30–35 by 14.5–15.7 μ; cilia aperture 4.2 μ in breadth; chromatophores numerous.—Fig. 3.

In marshes near Harbin.

TRACHELOMONES CUCURBITA **ovata,** var. nov.—Shell brown, smooth, 25–27 by 10.2–12 μ, tubelike neck 4.4 by 3.4 μ; in other respects similar to the species.—Fig. 4.

In marshes near Harbin.

Trachelomones vestita, sp. nov.; *T. hexangulata* Swir. var. *sinica* Skv., Jour. Asiatic Soc. Shanghai **4**:193. 1919.—Shell oblong or

hexagonal, with rounded end, 35 μ long, brown, lower part covered with spines, tubelike neck serrated.—Fig. 5.

Known only from marshes in South China.

Trachelomones schewiakoffii, sp. nov.; *T. rhombica* Skv. var. *planktonica* Skv., Jour. Asiatic Soc. Shanghai **4**:53. 1919.—Shell oval, contracted at both ends, brown, smooth, 30 by 20 μ; neck 5.5 by 3.5 μ; chromatophores numerous.—Fig. 6.

Named in honor of Dr. W. T. SCHEWIAKOFF, well known Protistologist of Irkutsk University, Siberia, Russia.

TRACHELOMONES SCHEWIAKOFFII var. **polonica** (Koczw.) nob., comb. nov.; *T. polonica* Koczwara, Kosmos, Lwow **40**:231–275. 1915.—Shell oval, contracted at both ends, more pointed at end, 35–38 by 15–17 μ, tubelike neck 4 μ long.—Fig. 7.

Known only in Biatogorski Lake in Polen.

Trachelomones woloszynskii, sp. nov.; *T. eurystoma acuta* Lemm. Kryptog. Mark Brand. **3**:528. 1910; STEIN, Ker Organismus der Infusionstiere **3**:1878; PASCHER et LEMMERMAN, Die Süsswasser Flora Deutschlands **2**:151. 1913.—Shell brown, smooth, rhomboidal with rounded end and very broad middle part, neck cut obliquely; chromatophores numerous.—Fig. 8.

Known from Europe.

TRACHELOMONES WOLOZYNSKII ASPERA Skv.; *T. regularis* (Lemm.) Skv. *asperum* Skv. Jour. Microbiol. **4**:71. 1917, and Winter phytoplankton of the fish ponds of Foochow **53**:193. 1922.—Shell more elongate, 27.8 by 13 μ, brown, covered with knobs, neck straight; cilia 1.5 times longer than shell; chromatophores numerous.—Fig. 9.

Known from South China and Manchuria.

TRACHELOMONES WOLOZYNSKII **longicollis,** var. nov.; *T. regularis asperum* Skv. *forma,* Winter phytoplankton of the fish ponds of Foochow **53**:193. 1922.—Shell brown, covered with knobs, contracted at both ends and broadly rounded, 27 by 12 μ. upper part passing directly into serrated neck.—Fig. 10.

Known only in South China in fish ponds.

Trachelomones kozlovii, sp. nov.—Shell oval, rough, transparent, 81.4 by 47 μ, upper part contracted and passing directly into neck cut obliquely and 7.4 μ broad, lower part contracted and little

drawn out and rounded; chromatophores numerous; stigma distinct; paramylons small and round.—Fig. 11.

Found only near Harbin.

Named in honor of I. W. KOZLOV, who collected this form.

Trachelomones rapacea, sp. nov.; *T. volgensis chinensis* Skv. Jour. Asiatic Soc. Shanghai **4**:7. 1919.—Shell brown, covered with knobs, spherical, contracted and pointed at the end, 38–40 by 21–25 μ; chromatophores numerous; stigma distinct; paramylons small and round.—Fig. 12.

Known only from South China.

Trachelomones stagnalis, sp. nov.; *T. fluviatilis curta* Skv. Jour. Asiatic Soc. Shanghai **4**:54. 1919.—Shell brown, broad, oval, contracted at both ends, upper part passing directly into neck 2.5 μ broad, lower part pointed, 22 by 16 μ; chromatophores numerous.—Fig. 13.

In marshes near Harbin.

TRACHELOMONES TAMBOWIKA SWIRENKO **amphora,** var. nov.—Shell oval, smooth, neck enlarged at end to 7 μ broad, 44.4 by 29.6 μ, lower part of shell pointed, end spine 11.1 μ long; chromatophores numerous; stigma distinct.—Fig. 14.

In plankton near Harbin.

TRACHELOMONES URCEOLATA STOKES var. HYALINA (Swir.) nob.; *T. hyalina* Swirenko, Trav. Inst. Bot. Univ. Kharkoff, no. 26. p. 25. 1915.—Shell transparent, covered with small knobs, elongate oval 62 by 32 μ, upper part passing directly into serrated neck, lower part pointed; chromatophores numerous, 6.5 μ in diameter; stigma distinct, 4.5 μ in diameter; paramylons small, elongate.—Fig. 15.

Known only from ponds in Russia.

TRACHELOMONES ENSIFERA DADAY var. LONGICAUDA (Swir.) nob.; *T. longicauda* Swirenko, Beitr. Kent. Flagell. der Charkow. 1913.—Shell brown, rough, spherical, contracted and pointed at end, 44–5 by 22–29 μ, end spine 21 μ long, upper part passing into neck 12 by 7 μ, oblique; stigma round, 3 μ in diameter; paramylons oblong or round.—Fig. 16.

At present found only in ponds of Russia.

TRACHELOMONES SCHAUNINSLANDII **manschurica,** var. nov.—Shell stiff, oval, covered with small knobs, 66.6–70.3 by 30–40.7 μ,

end contracted and pointed, upper part passing into oblique neck 5.7–6 μ broad; chromatophores numerous; stigma distinct.—Fig. 17.

In marshes in North Manchuria.

TRACHELOMONES INFLATA **crenulatocollis,** var. nov.—Shell brown, covered with dots, elongate, oval, contracted at both ends, 66.6 by 31 μ, lower contracted part rounded and with a small spine at end; neck straight, brown, smooth and serrate, 7.4 by 5.7 μ, distinct from shell.—Fig. 18.

Known only from plankton near Harbin.

Trachelomones dangeardii, sp. nov.; *T. fluviatilis* Lemm. in SWIRENKO, Archiv Hydrobiol. Plank **9**:640–645. 1914.—Shell oval, brown, smooth or rough, 25.9 by 11.1–17 μ, upper part passing directly into neck which is enlarged at end to 5.5 μ in diameter; chromatophores 4 or 5, without pyrenoids; cilia 2–3 times longer than shell; paramylons small, round.—Fig. 19.

Known only in Russia and North Manchuria.

Named in honor of Professor P. A. DANGEARD, of France.

TRACHELOMONES DANGEARDII var. **glabra,** comb. nov.; *T. fluviatilis glabra* Skv. Jour. Asiatic Soc. Shanghai **4**:54. 1919.—Shell oval, brown, covered with knobs, 26 by 14.1 μ, neck oblique; chromatophores numerous.—Fig. 20.

In marshes near Harbin.

TRACHELOMONES DANGEARDII var. LAVERTA (Swi.) nob.; *T. fluviatilis lacerta* Swirenko, Trav. Inst. Bot. Univ. Karkoff, no. 26, p. 30. 1915.—Shell brown, smooth, spherical, contracted and pointed at end, 32–34 by 14–16 μ, end spine 10 μ long, upper part passing directly into serrated neck 7 μ long and broad.—Fig. 21.

In marshes of Russia.

TRACHELOMONES HELVETICA **manschurica,** var. nov.—Shell brown, covered with sharp pointed spines, oval, contracted at both ends, 40.7 by 18.5 μ; neck straight, 5.7 μ broad, distinct from shell; lower part pointed and rounded at end; chromatophores numerous.—Fig. 22.

In plankton near Harbin.

TRACHELOMONES SWIRENKO Skv. **sinensis,** var. nov.—Shell brown dotted and only in lower part covered with knobs, contracted

at both ends, 40.7 by 18.5 μ, upper part passing directly into neck, 4 by 4.5 μ; chromatophores numerous.—Fig. 23.

As yet found only near Harbin.

TRACHELOMONES FLUVIATILIS LEMM. var. LEVIS (Lemm.), comb. nov.; *T. affinis levis* Lemm., FORSCH. Biol. Sta. Plön **2**:157; Kryptog. Mark Brand. **3**:530. 1910; PASCHER et LEMM., Die Süsswasser Flora Deutschlands, **2**:153. 1913; SKVORTZOW, Winter phytoplankton of the fish ponds of Foochow **43**:193. 1922.—Shell oval, contracted at both ends, 60–68.5 by 26–27 μ, upper part passing directly into neck, which is 5.7 by 5.5 μ, lower part pointed.—Fig. 24.

Found in Europe and South China.

Trachelomones maxima, sp. nov.—Shell oval, contracted at both ends, 103.6–107 by 40.7–44.4 μ, upper part passing directly into neck, which is 7.4 μ broad and oblique, lower part pointed; chromatophores numerous; stigma distinct; paramylons round or long.—Fig. 25.

In plankton near Harbin.

Trachelomones nadsonii, sp. nov.—Shell brown, contracted at both ends, 66.6 by 22.5 μ, upper part passing directly into neck, which is 9.2 by 5 μ and serrate, lower part pointed, end spine 14.8 μ long; chromatophores numerous; paramylons round.—Fig. 26.

In plankton near Harbin.

Named in honor of Dr. G. A. NADSON of Leningrad, Russia.

Trachelomones baikovii, sp. nov.—Shell brown, covered with spines, oval, contracted at both ends, 51.8–55.5 by 23–25.9 μ; neck straight, serrate, 7.4 by 5.7 μ, distinct from shell; lower part of shell with thick rounded spine; chromatophores numerous; stigma distinct; paramylons small; cilia larger than shell.—Figs. 27, 28.

Found near Harbin.

Named in honor of N. A. BAIKOV, a well known naturalist in Manchuria, who has found this form.

TRACHELOMONES ACUMINATA (Schmarda) Stein; *Lagenella acuminata* Schmarda, Denkschr. Wiener Akad. Wiss. **1**:1850; LEMMERMANN, Kryptog. Mark Brand. **3**:525. 1910; PASCHER et LEMMERMANN, Die Süsswasser Flora Deutschlands, **2**:151. 1913; SKVORTZOW, Winter phytoplankton of fish ponds of Foochow, p. 192.

1922.—Shell smooth, trapezoid, 50–59 μ long, upper part passing directly into oblique neck, lower part pointed; cilia twice as long as shell.

Known from Europe and South China.

TRACHELOMONES ACUMINATA **triangulata,** var. nov.; STEIN Der Organismus der Infusionstiere 3:1878; LEMMERMANN, Kryptog. Mark Brand. 3:151. 1910; PASCHER et LEMMERMANN, Die Süsswasser Flora Deutschlands, 2:151. 1913.—Shell triangular; in other respects similar to typical form.—Fig. 29.

Known from Europe.

TRACHELOMONES ACUMINATA VERRUCOSA Teodoresco, Beih. Bot. Centralbl. 21:215; SKVORTZOW, on phytoplankton from ponds of Tientsin, p. 189. 1922.—Shell brown, covered with knobs, 26–34 by 14–22 μ.—Fig. 30.

Found in Rumania and North China.

TRACHELOMONES ACUMINATA MAJOR Skv., Jour. Microbiol. 4:70. 1917.—Shell transparent, smooth, 90–92.9 by 37.4–38 μ, neck oblique; chromatophores numerous; stigma distinct.

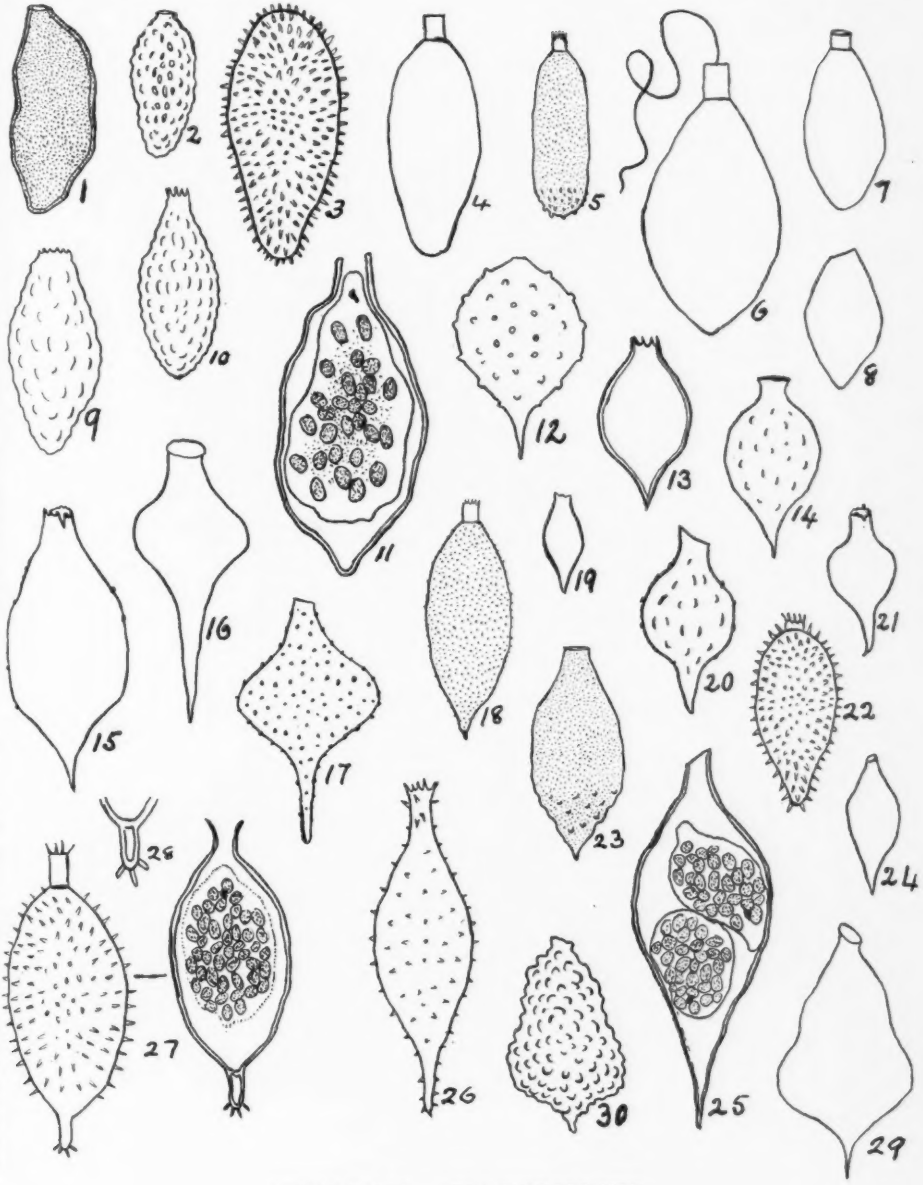
In plankton from Manchuria.

HARBIN, MANCHURIA
CHINA

EXPLANATION OF PLATE VII

FIG. 1.—Trachelomones tuberosa.
FIG. 2.—T. tuberosa conspersa.
FIG. 3.—T. cucurbita.
FIG. 4.—T. cucurbita ovata.
FIG. 5.—T. vestita.
FIG. 6.—T. schewiakoffii.
FIG. 7.—T. schewiakoffi polonica.
FIG. 8.—T. woloszynskii.
FIG. 9.—T. woloszynskii aspera.
FIG. 10.—T. woloszynskii longicollis.
FIG. 11.—T. kozlovii.
FIG. 12.—T. rapacea.
FIG. 13.—T. curta.
FIG. 14.—T. tambowika amphora.
FIG. 15.—T. urceolata hyalina.
FIG. 16.—T. ensifera longicauda.

FIG. 17.—T. schauninslandii manschurica.
FIG. 18.—T. inflata crenulatocollis.
FIG. 19.—T. dangeardii.
FIG. 20.—T. dangeardii glabra.
FIG. 21.—T. dangeardii lacerta.
FIG. 22.—T. helvetica manschurica.
FIG. 23.—T. swirenko sinensis.
FIG. 24.—T. fluviatilis levis.
FIG. 25.—T. maxima.
FIG. 26.—T. nadsonii.
FIG. 27.—T. baikovii.
FIG. 28.—T. baikovii.
FIG. 29.—T. acuminata triangulata.
FIG. 30.—T. acuminata verrucosa.



SKVORTZOW on TRACHELOMONES

VASCULARIZATION OF THE NODE IN ZEA MAYS

ARTHUR T. EVANS

(WITH SEVEN FIGURES)

The fate of the vascular bundle, once it reaches the node of the stalk in a corn plant, has remained a baffling situation for years. Imbedding of tissue from the node and then sectioning has been found inadequate in the study of the node, since the branching of the vascular bundle is so intricate and the branches so tortuous as to defy solution, even in the best prepared serial sections. Single vascular bundles passing through the node may clearly be demonstrated by sections, but they do not definitely represent the true situation.

The writer has been interested in a study of the vascular system in the corn plant for a number of years. It was not until recently, however, that a technique capable of showing the true situation in the node was developed.

Material

A number of young corn plants were collected and an effort made to trace the vascular system by staining it with methylene blue. When the whole end of the stalk was inserted into the stain, it was found to become so completely colored as to obscure the course of individual bundles through the nodes. Later, a number of stalks were cut away in such a manner as to leave only three or four bundles, about an inch long, protruding from the end. These bundles, which were in the center of the stalk, were inserted into a container of methylene blue so that they alone were in a position to conduct the stain. This method was found to be unsatisfactory, however, since the plant soon wilted and died. The method was later improved, the few strands to be stained being inserted into a small vial of methylene blue and the mouth of the vial thrust up into the base of the stalk. The end of the stalk could then be placed, bottle and all, into water and the plant thus kept alive (fig. 1).

Through the use of this method the methylene blue was taken up readily by the bundles before the plant wilted. The right degree of

staining could be obtained by proper manipulation. The bundles could then be clearly traced through several nodes of the plant. Any branching that occurred was easily noticed in the nodes. At first it was decided to dissect out the stained bundles, but this became a hopeless task; although easy in the internodes, it became far too intricate in the nodes. Some of the stained material was placed in a warm place for a few days, and, when examined later, it was found that it had been retted by the action of bacteria, so that the parenchymatous cells were easily removed by washing. This left the stained nodal bundles as a network of vascular strands, which showed excellently under the binocular microscope. These vascular strands in freshly killed material are so elastic that they will withstand a great amount of rough usage.

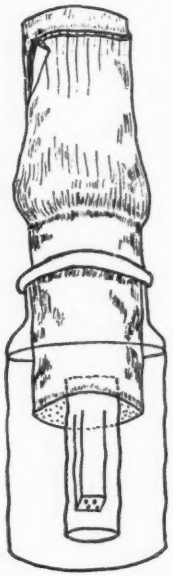


FIG. 1.—Apparatus for staining a few vascular bundles at a time. Stalk is cut as indicated, leaving only three or four vascular bundles protruding; small vial filled nearly full of methylene blue is placed over these and mouth inserted into base of corn stalk; end of stalk is then placed in bottle of water, upper part being left intact. In this manner stalk remains alive for many days.

After washing away thoroughly all the parenchyma with its protoplasm, the specimens were placed in alcohol and later in glycerine, where they were readily kept and cleared into beautiful specimens, the blue bundles showing up well when freed from the obscuring tissues which surrounded them.

ARTSCHWAGER,[1] in a paper dealing with the anatomy of the sugar cane, discusses the vascular situation in the nodes. He states that many of the bundles pass through seven or eight nodes, but that their absolute length cannot be determined with certainty. STRASBURGER[2] states that in *Zea mays* the longest leaf trace passes through six

[1] ARTSCHWAGER, ERNST, Anatomy of the vegetative organs of sugar cane. Jour. Agric. Res. **30**:197–221. 1925.

[2] STRASBURGER, E., Über den Bau und die Vorrichtungen der Leitungsbahnen in den Pflanzen. Histologische Beiträge. Heft III. pp. 1000, illustrated. Jena. 1891.

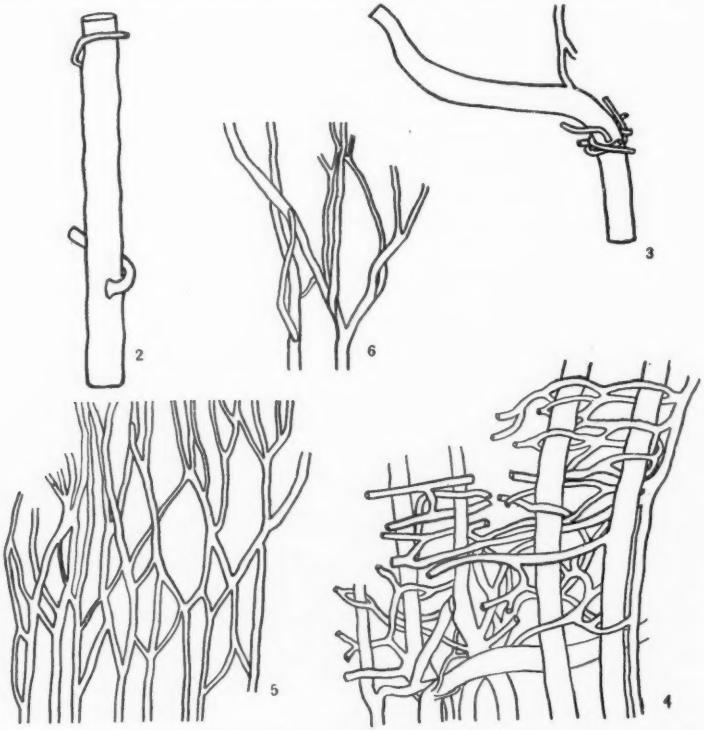
internodes. In this investigation no bundle was found to pass through more than three nodes without branching. There can be no difficulty in noting this, as each bundle may be dissected out in its entirety. There are few bundles which do not give off at least a small branch at each node. Often these small branches are so minute as to escape unnoticed unless examination is made with some magnification. In some cases there appear to be no large branches given off for several nodes. The writer is of the opinion that there is a considerable amount of variation in this matter. In many cases the bundles branch more or less at each node; again, they may not.

The branching of the bundles usually occurs as the bundle enters the node. In this position it is enlarged, and it is from such an enlargement that the branches arise. There are few, if any, of the principal vascular strands which pass through a node without at least some slight alteration. Many are merely deflected to one side or the other; others are flattened and widened; and again they develop the small branches mentioned previously. It can be said with certainty that only a very small number pass uninterrupted through the node; the great majority either branch, change their course, or are modified in form. To be sure, a great number of the bundles pass directly through the node with little more than very slight modification. Such bundles may traverse through one or two nodes before entering the leaves or branching profusely; in some cases the entire bundle is dissipated into a mass of small branches. Fig. 2 represents a single bundle which gives rise to but two small branches into the network of node bundles. This bundle, before dissecting out, appears to pass through the node without branching.

In fig. 3, which is a drawing of one of the large central bundles, showing its course out toward the epidermis to enter the leaf, a great number of branches are given off at the point where it enters the node. A study of the node shows that a large mass of the intertwining bundles which make up the node complex arises at this level, which is just at the point of entry of the bundles

Fig. 4 is a portion of a section from a node, showing the intricate manner in which the bundles interlace. At the extreme right may be seen a small bundle that gives rise to a series of nodal branches which loop about the nearby vascular strands. It is such small periph-

eral bundles as these that are largely responsible for the network of bundles which give rise to the network of fibers found in the upper



FIGS. 2–6.—Fig. 2, single vascular bundle showing two small branches arising at different levels; fig. 3, single vascular bundle showing course as it passes from center of stalk into leaf, small branch continuing upward through node; number of small branches arise from bundle at point near lowest part of node; bundle flattened and somewhat widened; fig. 4, detailed drawing showing course of various small nodal bundles; note looping of small branches about vascular bundles in upper part of node; fig. 5, number of bundles as seen in outer part of stalk, showing anastomosing character; fig. 6, intricate method of branching found in node.

part of the nodes. These join with the branches which arise from the larger vascular bundles at lower levels to form the complicated vascular situation of the node. Fig. 5 represents a number of these peripheral bundles as they lie just beneath the cortex. This drawing

is a view of the meshwork of peripheral bundles such as are found in the vicinity of each node. Although the smaller peripheral bundles appear to be responsible for most of the minute branches in the node complex, there is a comparable number of these smaller branches which arise from the larger vascular strands as they enter the node. These small branches continue to divide and subdivide through the node, and eventually anastomose with other small branches from other bundles, thus finally becoming joined with other vascular elements at the same level or slightly above the point of their departure from the original bundle. In no case is there a general attachment of the numerous small fibers with the main vascular bundles at high levels in the node. Although an occasional branch unites at some distance above the lower edge of the node, this is not the general situation, since a preponderance of the bundles branching in any node do so from the definite enlargement near the lower edge of the node proper. From this point they ramify through the parenchymatous tissue of the node in all directions, many becoming united with similar small branches from the peripheral bundles. So complicated does the branching become that it is impossible of tracing, even when no other tissues are present to complicate the situation. Many of these small branches subdivide and fuse with others, until they are completely lost in a maze so intricate as to become bewildering (fig. 4).

The methylene blue conducted through the vascular bundles, once it reaches the node, spreads confusingly through it, showing that there is no fixed path by which materials traverse the structure. Apparently materials of whatever type, once they reach the node, pass through any bundle into which chance may carry them. The bulk of the stain remains in the main vascular bundle, and passes directly through the node into the leaf, or into the many branches which arise from it, as the case may be. When the stain enters the small secondary branches of the node, it may often be carried some distance across it, and even into vascular bundles which are without stain when they enter the node.

Fig. 7 is a photomicrograph of a section of the retted node, and shows well the network of bundles. It will be noted that one of the large bundles gives rise to several small branches at its lowest level

in the node. Other branches may be seen to pass off at higher levels. The figure shows the branches passing from higher to lower levels in the node, as well as back and forth across it. Also the main bundle (*B*) shows how such a structure traverses through the node after giving off branches. Two small branches are seen to arise from this

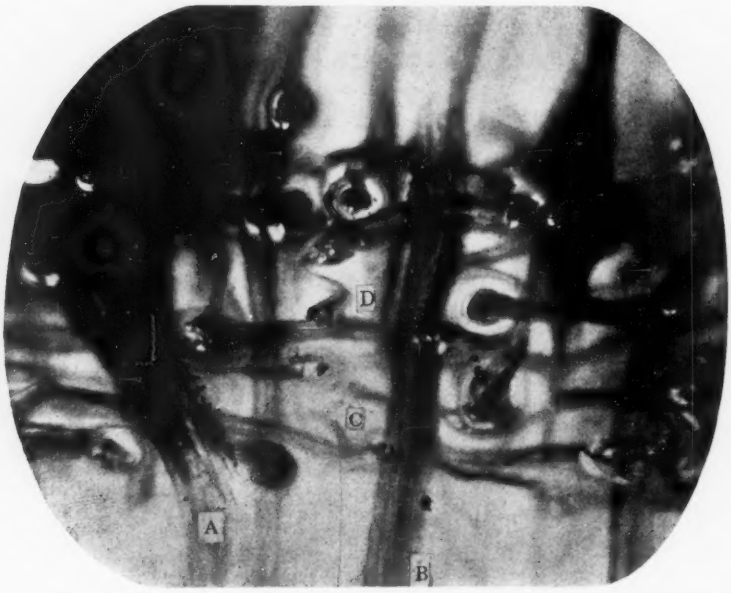


FIG. 7.—Photomicrograph of portion of retted node, showing passing of many small branches in every direction: vascular bundle *A* bends toward leaf after branching; *B* passes more or less directly through but gives off branches at two levels; *C* and *D* show passing of small branches from one level to another and their method of uniting. Photomicrograph by LEITZ.

bundle at its lowest point; one is attached on the upper left surface, the other on the lower right. At *C* one of the numerous small bundles to be found in every node connects the branch from the left of vascular bundle *B* with another branch at a different level. At *D* two nodal branches of larger size pass to the right and left from bundle *B*. These are at a higher level than are those at *C*.

Bundle *A* branches as it enters the node, a smaller branch bundle

continuing through it without much interruption. At two points, however, nodal bundles join this smaller branch. In various parts of the microphotograph may be seen bundles of smaller size passing from one level to another after traversing across the node for some distance. It should be borne in mind that this is but a minute piece of a large node; when viewed with a binocular or examined with the naked eye, the vascular bundles with the branches given off in the node make a rather confusing network.

In fig. 4 there is shown a single vascular bundle, its course being deflected into the leaf. A single bundle, dissected out, is shown in fig. 3. Such bundles almost without exception give off a series of small branches at the point where they first bend in the node toward the leaf. This is always at the point of their entry or the lower edge of the node. The small branches thus given off enter the nodal complex and unite with the many other similar small branches to be found there.

Summary

1. The vascular strands in *Zea mays* can readily be stained for study with methylene blue, as shown in fig. 1.

2. The stained bundles and the complex nodal structure can readily be freed from confusing parenchymatous tissues by retting.

3. Single vascular bundles seldom pass through more than two or three nodes without branching.

4. The nodal complex of small branches arises from vascular bundles at the point of their entry into the node and from smaller peripheral bundles.

5. The nodal complex is the result of division and subdivision of these small bundles, which later anastomose with those from other bundles.

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CLEISTOGAMY IN TWO SPECIES OF DANTHONIA[1]

PAUL WEATHERWAX

(WITH PLATE VIII AND TEN FIGURES)

Danthonia is one of a number of genera of grasses known to have two kinds of spikelets, one kind in the ordinary terminal inflorescence, and another kind, seldom seen, in the axils of the leaves.[2] A comparative study of these two types of spikelet in *Danthonia spicata* (L.) Beauv. and *D. sericea* Nutt. has shown some other interesting features apparently not previously known.

Material

D. spicata is widely distributed in the eastern part of the United States. In Indiana its clumps of curly leaves often stand out as a striking feature of the winter flora of clay hills so poor as to support little else in the way of a ground covering. Material for this study was collected in open fields and in the woods on poor clay soil north and east of Bloomington, Indiana, and supplemented with occasional specimens from other parts of the state. *D. sericea* is reported as occurring on sandy soil from Massachusetts southward to Florida. A typical habitat is the pine woods on red, sandy clay soil of the Piedmont region. Material was collected from several places in Georgia, chiefly near Athens and Unadilla. Both species were identified by careful comparison with the descriptions and with material from the same or similar localities, which had been identified by Dr. A. S. HITCHCOCK or Mrs. AGNES CHASE.

Danthonia spicata

The flowering culm of *D. spicata* may vary from a few inches to as much as 3 feet in height (fig. 1). It bears a single terminal panicle, which has only a few short branches, and usually not more than ten or twelve spikelets. At the base of each culm is a cluster of three to six leaves, some having lived through the winter, the others being

[1] Publication no. 31 of the Waterman Institute for Scientific Research, Indiana University.

[2] CHASE, AGNES, Amer. Jour. Bot. 5:254–258. 1918.

of the current year's growth. In the axil of almost every one of the latter (fig. 1 *ab*), completely inclosed by the sheath, is a single spikelet. These spikelets are usually one-flowered (fig. 2); but higher on the culm, where the internodes are much longer (fig. 1 *ac*), the axillary spikelets often have as many as ten florets scattered along a greatly elongated rachilla (fig. 3).

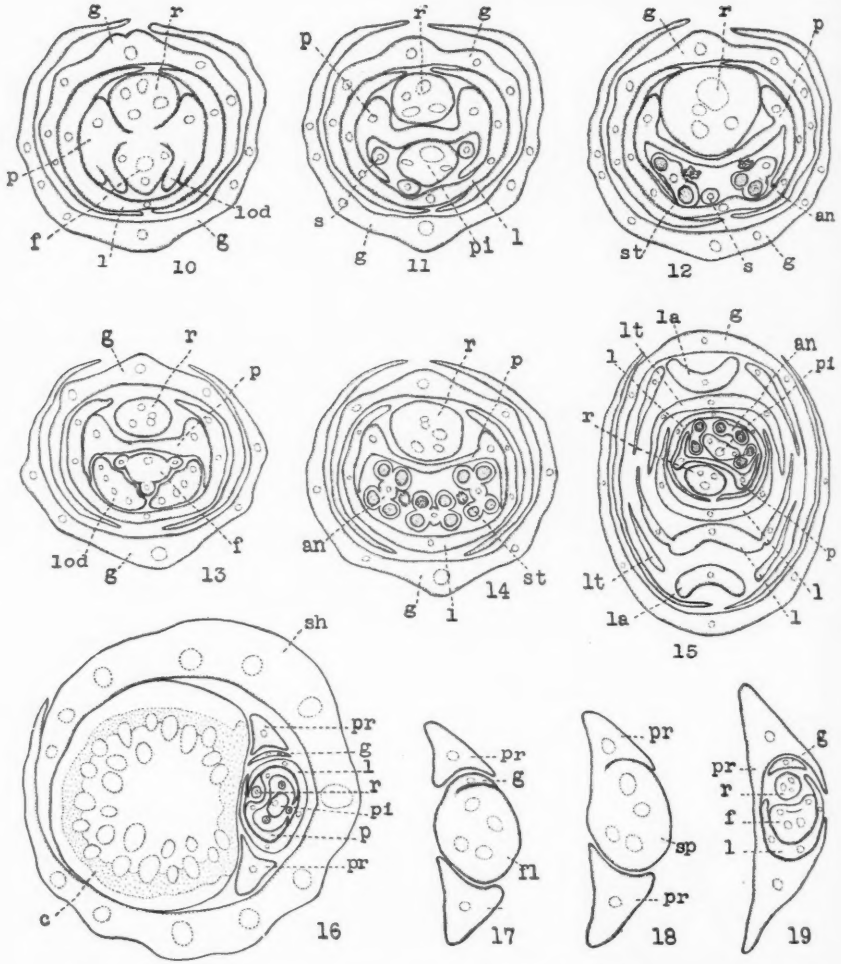
The spikelets in the terminal inflorescence (fig. 4) show no unexpected peculiarities in external appearance. Their lowest flowers are oldest, and the upper florets of each are usually imperfect or rudimentary. The glumes are usually as long as the rest of the spikelet.

The key to the peculiarities of the flower in both kinds of spikelets seems to be in the fact that the lodicules (figs. 6, 10 *lod*) are rudimentary and poorly supplied with vascular tissue, and the floret does not open at anthesis. The styles are short, and the stigmatic hairs are few and poorly developed. The anther is short and broad (figs. 5, 6). Each of its two loculi (fig. 12) contains only a few (40–60) pollen grains. Before the maturity of the pollen, the anthers become applied to the stigma, apparently adhering there or being held mechanically by the stigmatic hairs or by the closely investing lemma and palea (fig. 5). At anthesis they cannot be raised higher because the floret does not open, and the filaments, elongating as in other grasses, become coiled or otherwise distorted (fig. 6).

In such descriptions of *Danthonia* and its species as have been available, no special mention was found of the anther or lodicules, or of the nature of anthesis. The figure of the spikelet and floret of *D. spicata* in GRAY'S *Manual* (7th edition) is the only definite thing found on this point; it is most certainly wrong if my material is typical, for it shows anthers four times as long as wide, and distinctly exserted from the open floret on long filaments. It seems improbable, however, that this occurrence of cleistogamy should have escaped observers thus far.[3] It is most strikingly seen when developing or mature seeds are examined, the empty anthers being invariably found tangled in the hairs of the stigma.

The exact homologies of the parts of the axillary units (figs. 2, 3)

[3] Since this was written I have found that HACKEL (Nat. Pflanzenfam. II. 2:9) mentions *Danthonia spicata* in a short list of cleistogamous species.



FIGS. 10–20.—Figs. 10–12, transverse sections of terminal spikelet of *D. spicata* at different levels: *g*, glume; *l*, lemma; *p*, palea; *r*, rachilla; *s*, filament of stamen; *st*, stigma; *an*, anther; *pi*, base of pistil; *lod*, lodicule; ×20; figs. 13–15, transverse section of terminal spikelet of *D. sericea* at different levels: *f*, base of stamens and pistil; *la*, *lt*, awn and teeth of lemma; remainder of legend as in figs. 10–12; ×20; fig. 16, transverse section just above culm node in *D. spicata*, showing axillary spikelet in position: *c*, culm; *sh*, sheath of subtending leaf; *pr*, prophyllum; other parts of legend as in figs. 10–15; ×15; figs. 17, 18, sections of axillary spikelet (*D. spicata*) at different levels, showing relation of glume to lobes of prophyllum: *fl*, base of floret; *sp*, base of spikelet; otherwise as in preceding figures; ×20; fig. 19, section of axillary spikelet of *D. sericea*, legend as in preceding figures.

are not clear. On the outside are two slender structures (figs. 2, 3, 16–18 *pr*) which might be regarded as glumes were they not associated with a third bract (figs. 16, 17 *g*), which also has the character of a glume. Tracing the vascular tissue has failed thus far to give any material aid.

The floret is essentially much the same as in the terminal spikelets. The lemma and palea are a little more indurated, and the former is awnless in some of the one-flowered spikelets, but usually awned in the upper florets of the elongated spikelets (figs. 2, 3). The pistil and stamens are identical in appearance with those of the terminal spikelets. No lodicules have been observed.

In both inflorescences the florets disarticulate from the rachilla, and the caryopsis remains inclosed in the lemma and palea. Fruits from the terminal spikelets are readily dispersed by the wind or other agencies; those from the axillary spikelets remain in the leaf sheaths and are scattered when the culm breaks away at maturity. In some cases the two types of disarticulated floret differ greatly in appearance, because of the variable nature of the lemma, but there seems to be no consistent difference in the caryopsis. Seeds from both sources germinate alike, and seedling plants observed until flowering, the second season after germination, are alike in appearance and vigor.

Danthonia sericea

Except for minor details, the individual plant of *D. sericea* is much like that of *D. spicata* in appearance. The terminal panicle often has as many as twenty spikelets. These do not differ materially from those of *D. spicata*. All the axillary units observed are one-flowered (fig. 7), however, and none have been found except at the two or three lowest nodes, at the very base of the culm. The outer part of each of these units, moreover, consists of a single bract (figs. 7, 19 *pr*), which seems to be equivalent to the two prominent lateral structures of the same organ in *D. spicata* (figs. 2, 3, 16–18 *pr*). The third glumelike scale is also present (fig. 19 *g*), but smaller than in *D. spicata*, seldom reaching higher than the base of the ovary. In the floral parts little difference between the species is seen except in the degree of development reached by the anthers and lodicules. In the axillary spikelets (fig. 9) the anthers are somewhat

longer and better developed than those of *D. spicata*. Lodicules are apparently not present. In the terminal spikelets the lower flowers have long, tetrasporangiate anthers (figs. 8, 14) and large, well developed lodicules (fig. 13), which do not function, however, at least not in the ordinary way. The upper flowers have bisporangiate anthers (fig. 15), and their lodicules are rudimentary if present at all. The anthers in the middle of the spikelet show various stages of degeneration of the ventral pair of sporangia; but in a few cases both sporangia on one side of the anther degenerate, leaving an asymmetrical structure.

Interpretation

Most of the floral structures of both species are readily explained in terms of the ordinary morphology of grasses, but the identity of the bracts at the base of the axillary spikelet is not clear at present. Of the homology of the two structures in *D. spicata* with the one in *D. sericea* (*pr* in all figures) there can be little doubt; but their relation to the rest of the axillary branch is less evident. Two interpretations are possible:

1. In *D. spicata* two separate glumes are present, and these are united into a two-keeled, two-nerved structure in *D. sericea*. The third very small bract in both species is an additional glume (or sterile lemma) such as occurs in *Uniola*, *Phalaris*, etc.

2. The axillary branch in each case bears a prophyllum, which is normal in *D. sericea*, but cleft to its base in *D. spicata*. The third scale is the second glume of the spikelet, as indicated by its position with reference to the lemma. The first glume is lacking.

The latter explanation is the same as that advanced by Mrs. CHASE in the article previously cited, except that she did not find the glume. It is regarded as the more reasonable, and it is in accord with it that the figures have been labeled. It would be materially strengthened by the finding of the other glume, or of an axillary unit in which there were two or more spikelets above the structure regarded as a prophyllum. The study of other species of *Danthonia*, or of other genera having similar peculiarities, will doubtless be helpful in interpretation.

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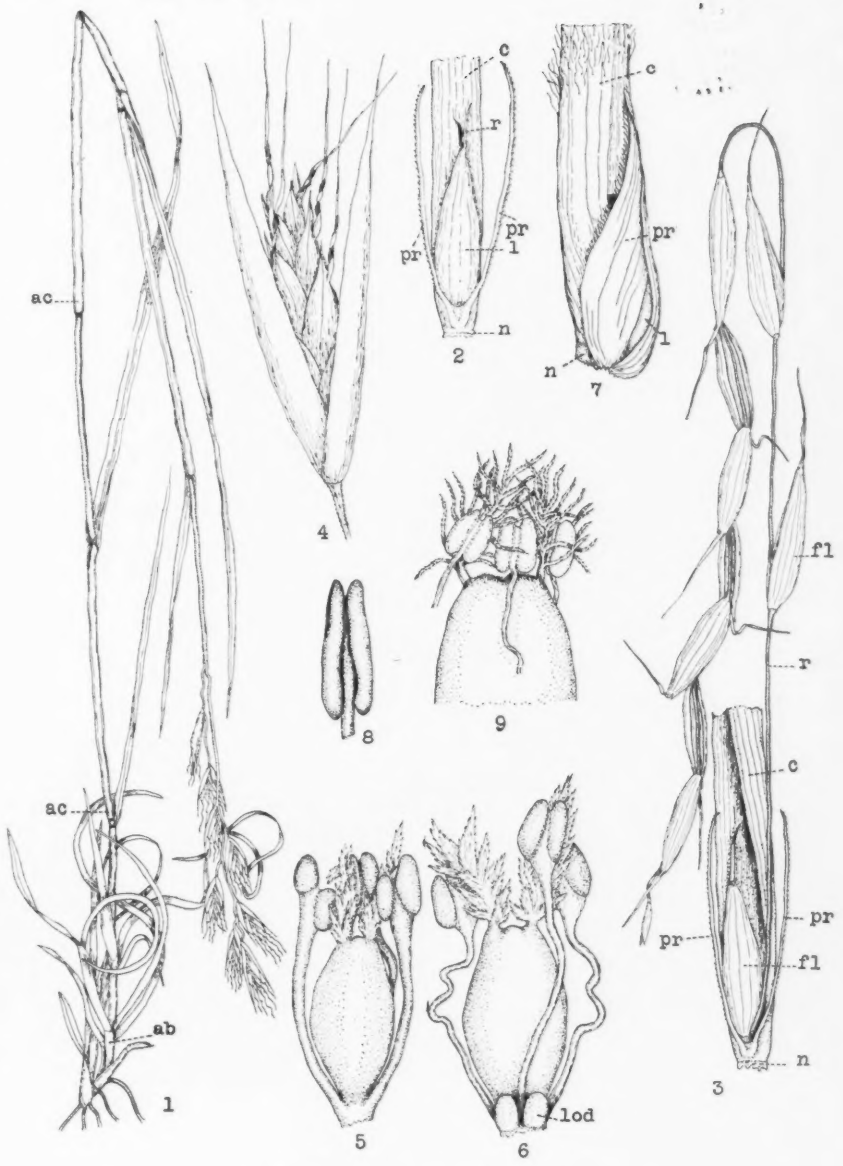

WEATHERWAX on DANTHONIA

EXPLANATION OF PLATE VIII

FIGS. 1–9.—*Danthonia spicata*. Fig. 1, one flowering culm: *ab*, basal axillary spikelets; *ac*, axillary spikelets higher on culm; ×½. Figs. 2, 3, spikelets from positions *ab* and *ac* respectively, indicated in fig. 1; ×4. Fig. 3, showing spikelet bent near middle: *pr*, lobes of prophyllum; *c*, culm; *l*, lemma; *r*, rachilla; *n*, node at which axillary unit is borne; *fl*, floret. Fig. 4, terminal spikelet; ×4. Figs. 5, 6, flower from terminal spikelet, before and after anthesis: *lod*, lodicule; ×30. Figs. 7–9, *D. sericea*. Fig. 7, basal axillary spikelet: *n*, node at which spikelet is attached; *c*, culm; *pr*, prophyllum; *l*, lemma; ×4. Fig. 8, anther from one of the lower flowers of terminal spikelet; ×20. Fig. 9, top of developing caryopsis, showing position of spent anthers; ×20. In figs. 5, 6, and 9 the stigmas are shown very diagrammatically.

STUDIES IN THE GENUS MENTHA

14. OXIDASES OF MENTHA PIPERITA

SAMUEL M. GORDON[1]

The manner in which cyclic compounds, especially those belonging to the so-called group of terpene compounds, are formed in the plant is as yet a field hardly beyond the speculative stage. Various theories have been proposed from time to time. Whether these theories fit the biochemical conditions is still a matter of conjecture, but they are interesting in at least providing a point of departure for experimental attack. The most satisfactory theoretical scheme which has been proposed is that of KREMERS (7). The outline proposed by KREMERS was intended to account for the relations found in three closely related botanical species of *Mentha*, *M. aquatica* L., *M. viridis* L., and *M. piperita* L. It satisfactorily accounts for most of the terpene bodies found in the volatile oils of these plants.

While the hypothesis in general clearly accounts for the biogenetic relations of the compounds present in the oil, much remains to be done along these lines. In the case of *M. piperita*, the problem of the menthol-menthone relations is still obscure. Menthol, both free and combined, forms over 50 per cent of the oil, while the content of menthone may vary between 10 and 15 per cent; yet the question as to which of these products is first formed is still a speculative one. Is menthol the first product formed, and then oxidized to menthone, or does a reduction process of menthone to menthol take place? To throw some light on this problem was the object of the investigation reported here.

In 1900, CHARABOT and coworkers (3) examined growing peppermint plants, grown in France, for the content and composition of the volatile oil isolated. They arrived at the following conclusions, which may be summarized briefly as follows: (1) At the beginning of the vegetation of the mint, the oil is rich in menthol, a small part of which is in the combined state. (2) Menthone exists only in

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minimal amounts at this period. (3) The menthone, which is but a small percentage of the oil at the beginning, increases with the vegetative process at the expense of menthol, the total menthol-menthone content remaining constant. (4) The oxidation takes place chiefly in the inflorescence. (5) The quantity of esters and terpenes increases, probably due to "diastase" (4).

In passing it might be mentioned that similar relations were found for a number of other volatile oil-bearing plants, which bear the peculiar alcohol-ketone and alcohol-aldehyde relation. In a summary of his researches CHARABOT states:

> Alcohol formation takes place in the first phases, the second phase takes part in that period of the plant life in which the respiratory energy exceeds that of assimilation. The quantity of oxygen absorbed by the tissues at that period is very considerable, and by this process the alcohols are oxidized to aldehydes and ketones.

Sometime later KLEBER (6) examined oils from peppermint plants of different ages and found the reverse relations to hold true, that is, the oil from the younger plants contained a larger percentage of menthone than oils from older plants. Here a reduction and not an oxidation process is involved.

While nothing is said of the biochemical agents concerned in the oxidation process, it is assumed that enzymes of an oxidizing nature may have been a factor in the transfer of oxygen, or involved in the oxidation of menthol to menthone as assumed by CHARABOT. In 1912 BROOKS (2), tacitly assuming the experimental results of the French workers, reasoned that aldehydes and ketones are formed from the respective alcohols by a process of direct oxidation. However, while BROOKS obtained positive tests for catalase and peroxidases by the usual reagents, he was unable to oxidize menthol to menthone by the aid of oxidase isolated from the plant.

Quantitative determinations of the amounts of catalase and peroxidase were made during the summer of 1926, in order to learn something of the mechanism involved in the oxidation processes taking part in the life of the plant. Catalase was determined by the usual method of measuring the oxygen evolved from H_2O_2 by a plant extract, while peroxidase was determined by the method of WILLSTÄTTER and STOLL (9).

Experimentation

The *M. piperita* used in this investigation was obtained from a strain of plants which has been grown for a number of years, with necessary cultural precautions, at the gardens of the Wisconsin Pharmaceutical Experiment Station at Madison. A plot of about 15 feet square, from the regular peppermint crop, was placed at the writer's disposal by the superintendent of the gardens.[2] In all of

TABLE I

Date	Oxygen (cc.) liberated, after minutes						
	5	10	15	20	25	30	35
July 15	36.10	48.3	48.9	48.9	.....	.....	.....
19	38.10	44.2	44.9	44.9	.....	.....	.....
23	55.85	59.6	59.8	60.1	60.1	.....	.....
August 2	80.50	88.7	90.8	91.1	91.1	.....	.....
9	67.90	78.5	87.9	91.6	93.8	95.0	96.5
16	51.00	60.3	61.0	64.7	64.7	.....	.....
24*	55.80	60.7	63.5	63.5	.....	.....	.....
	Florets alone used						
August 2	37.8	47.1	47.1	.....	.....	.....	.....
9	37.6	46.2	46.3	.....	.....	.....	.....

*Beyond this point it was difficult to obtain healthy samples of leaves, as the remainder of the field of mint was harvested and grasshoppers began destroying the plants.

these experiments not more than two hours elapsed between the time of harvesting and the determinations. The leaves were stripped from the stems, wrapped in waxed paper, and quickly transferred to the laboratory. Attempts were made to obtain as representative a sample as possible by picking leaves of different sizes and from different parts of a number of plants. Thus selected, the samples should yield a representative cross-section of the activity of the plant.

Catalase values

A 0.5 gm. sample of cut leaves was ground to a fine pulp in a mortar, using dry, clean, sea sand. The ground sample was quickly transferred to the apparatus suggested by Hawk (5), 20 cc. neutral H_2O_2 added, and the oxygen evolved collected and measured in a

[2] The gardens are under the immediate control of Dr. W. O. Richtmann, to whom I here express my thanks.

Schiff nitrometer. The volume of oxygen was reduced to standard conditions of temperature and pressure for purposes of comparison. A chloroform extract of the ground leaves did not liberate oxygen from hydrogen peroxide.

Peroxidase values

The peroxidase values were determined simultaneously with the catalase values described in the preceding section by the method of

TABLE II

Date	Purpurogallin produced (gm.)	"Purpurogallin number"*
July 15	0.02950	3.387
19	0.02930	3.363
23	0.03000	3.432
August 2	0.02691	3.089
9	0.05147	5.909
16	0.01538	1.765
24	0.00871	1.000
29	0.00915	1.050
	Florets alone used	
August 2	0.00861	0.988
9	0.00860	0.988

*The "purpurogallin number" as determined here is used in a different sense from the purpurogallin number of Willstätter and Stoll. The basis of their results depends on a weighed quantity of highly purified enzyme; the "purpurogallin number" as used here is obtained by dividing the amount of purpurogallin by 0.00871, the smallest amount of purpurogallin obtained. They represent ratios rather than absolute values.

Willstätter and Stoll. The test depends on the ability of the enzyme to oxidize pyrogallol to purpurogallin with hydrogen peroxide. The values are obtained by comparison with a standard solution of purpurogallin, containing 0.1 gm. in one liter of ether at 20° C.

Discussion

An examination of the catalase and peroxidase values for the leaves shows that the amounts of these enzymes increase up to the flowering period, then suddenly drop. On the other hand, the activity of enzyme extracts from the florets alone is much below the values obtained for the leaves at any period. So far as the florets are concerned, the figures are entirely contrary to Charabot's

statement that the seat of oxidation of menthol is in the inflorescence, if a direct oxidation is involved. The values for the leaf bear out CHARABOT'S contention, however, since the leaves show highest enzymatic activity during the flowering period. This again is contrary to CHARABOT, who maintains that dehydration, that is, formation of esters and terpenes, takes place in the leaf. This phase of the reaction, however, can have no relation to the oxidizing enzymes. However, these results may be correlated with CHARABOT'S contention by assuming that oxidation, if the oxidizing enzymes are involved, takes place in the leaf, and that the oxidized product, menthone, is transported to the flower, thus disturbing the equilibrium. In the introduction it was mentioned that when the florets were removed, very little menthone was found in the leaves by CHARABOT. From these results, it might be assumed that the leaf has a limited maximum capacity for retaining the oxidized product, which might inhibit the oxidation from being carried further, unless these products were removed. The function of the floret may then be considered as a storage medium for the menthone. In this way the oxidized products are carried from the leaf to the flower, lowering the amount of menthone in the leaf, and thus allowing further oxidation to proceed. By assuming such a mechanism of oxidation and transfer, the analytical results here reported may be brought into harmony with the data and contentions of CHARABOT.

While the peroxidases seem definitely to accelerate oxidation in biological process, the function of catalase is not definitely known. Two diverse views of the nature of catalase may here be presented. ABDERHALDEN (1) states, "the presence of catalase does not diminish the oxidizing powers of the other oxidizing enzymes." On the other hand, ROBERTSON (8) states, "Catalase is in fact a retarder of oxidations and not an accelerator, for it anticipates the action of peroxides and decomposes them, thus depriving them of their ability to transfer oxygen to oxidizing material. It is probably to be regarded as a controlling agent or check upon overactivity of oxidizing enzymes."

Another report will deal with attempts to oxidize menthol to

menthone by means of an extract of oxidizing enzymes from the plant, under a variety of conditions.

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8. ROBERTSON, T. B., Principles of biochemistry. Philadelphia. 1920 (p. 414).
9. WILLSTÄTTER, L., and STOLL, A., Über Peroxydase. Ann. Chemie **416**: 28–64. 1918.

CURRENT LITERATURE

BOOK REVIEWS

How a tree grows

A little volume by SOMERVILLE[1] begins with the cell and the growing stem tip, and describes in rather simple terms the structure of the various organs of the tree. Buds receive rather careful attention, but leaves are rather superficially considered. The stem and its wood structure occupy the larger portion of the volume. The various elements of the wood are clearly described, and the descriptions are illustrated by a series of very good drawings. The identification of various timbers by microscopic examination is described, and again the illustrations are clear and well suited to the purpose they are expected to serve. Among other topics discussed are root structure and mycorhiza, the origin and structure of the seed, the ascent of sap, the fall of the leaf, and the healing of wounds.

The entire discussion is of a type well suited to elementary studies in dendrology such as might be undertaken by junior college students. From the non-technical character of the language employed, the book may be read with interest and profit by amateurs interested in trees. The style is good, and in spite of the fact that the examples cited are mostly European species, it seems to meet a need in American schools in a successful and interesting manner.—G. D. FULLER.

Palms of India

A RECENT VOLUME[2] undertakes to describe the indigenous and introduced palms growing in British India. The botanical descriptions of the various species include both the scientific and common names used by the English and by the native tribes of India, together with notes on seedling habits, distribution, and cultivation. In many instances more space is devoted to economic uses than to the more strictly botanical features of the species. The large number of plates and text figures tend to bring the trees more vividly before the reader, in spite of the fact that the quality of many of the plates leaves much to be desired. Five tribes are described, including in all 131 species.

An extensive bibliography and good index conclude the volume.—G. D. FULLER.

[1] SOMERVILLE, W., How a tree grows. pp. 212. *figs.* 112. Oxford Univ. Press, American Branch, New York. 1927. $3.50.

[2] BLATTER ETHELBERT, The palms of British India and Ceylon. London, Oxford University Press. pp. xxviii+600. *pls.* 106. *figs.* 49. 2 maps. 1926. Printed at the Kanarese Mission Press, Mangalore, India. $15.00.

NOTES FOR STUDENTS

Plant distribution.—Although the present and the past distribution is critically known for a comparatively small percentage of the total number of plant families, genera, and species, this percentage constitutes a rather formidable group when the attempt is made to map each separately. The production of such a series of maps on a rather large scale is the ambitious aim of HANNIG and WINKLER.[3] It is certainly a task of no small difficulty, even with the assistance of such noted plant geographers as DIELS and SAMUELSSON, and the cooperation of a notable group of contributors. The latter are to include the most distinguished geobotanists of the day, if one is to judge from this first issue, which contains contributions by ENGLER, PAX, DIELS, VIERHAPPER, RIKLI, and HANNIG.

The general appearance of this publication recalls KARSTEN and SCHENCK's *Vegetationsbilder*, although it has an even larger page, 33×30 cm. Several of the ten maps in the first issue are of double-page size, and all are excellent in execution. The base map being in fine lines of blue, with the distribution limits in heavy black, the maps are easily read, while the high reputation of the contributors vouches for their accuracy. An explanatory text accompanies the maps. There is no doubt that this publication will be indispensable to all students of plant distribution.

In this first issue ENGLER maps the distribution of certain sections of the genus *Saxifraga;* PAX shows the areas occupied by the various subdivisions of *Acer* at present and during Tertiary times; DIELS maps *Casuarina;* VIERHAPPER, *Soldanella;* RIKLI, *Pinus pinea;* and HANNIG, *Genista angelica.* Not the least important feature of these contributions is extensive citations of the literature concerned.—*G. D.* FULLER.

Taxonomic notes.—EXELL[4] has published an account of the species of *Polygala* known in Angola, organizing the material in a way to reduce the difficulties of identification. It is of interest to note that of the 31 recognized species in this African country, 17 are endemic according to the present records, and only one species extends beyond Africa. One new species is described.

BROWN[5] has described a new genus (*Imitaria*) of Mesembryanthemeae from South Africa, which he regards as probably of hybrid origin from two crossing genera. He infers this from the intermediate characters it shows, a fact which he has recorded in the name.

[3] Die Pflanzenareale. Sammlung kartographischer Darstellungen von Verbreitungsbezirken der lebenden und fossilen Pflanzen-Familien, -Gattungen und -Arten. Edited by HANNIG and H. WINKLER with the cooperation of LUDWIG DIELS and G. SAMUELSSON. *1:* heft 1. *maps 1–10. 1926.* Published by GUSTAV FISCHER, Jena. 7.50 mk.

[4] EXELL, A. W., An enumeration of the species of *Polygala* in Angola. Jour. Bot. **65**:339–347. 1927.

[5] BROWN, N. E., Two new Mesembryanthemeae. Jour. Bot. **65**:348–349. 1927.

In continuation of his investigation of the flora of tropical Florida, SMALL[6] has described a new species of *Lechea* (Cistaceae), "which grows in the most southern island of scrub known on the eastern coast." He has also described[7] a new species of *Chamaesyce* (Euphorbiaceae), which grows in the pineland region of the Everglade Keys.

LEWTON[8] has described a new genus (*Shantzia*) of Malvaceae from Africa formerly referred to *Thespesia*. The name is in honor of H. L. SHANTZ, who as Agricultural Explorer obtained the seeds in Rhodesia in 1919. The plants grown from the seeds have been under observation for several years, with the final conclusion that they represent an undescribed genus.

In continuation of his revision of the grasses of Japan, HONDA[9] has published 6 new species in 5 genera, and also 5 new varieties, and 3 new names.

LEONARD[10] has published the result of his investigation of *Ruellia tuberosa* (Acanthaceae) and related forms. The forms considered are distributed in the West Indies and adjacent South America and the United States. Under *R. nudiflora* 8 varieties are recognized, 6 of which are new and 2 transferred from other species.

STANDLEY[11] has described 12 new species of plants from Central America in 6 genera, 7 of the species belonging to *Ardisia* (Myrsinaceae).

In continuation of his publication of Portuguese West African plants, GOSSWEILER[12] has described 4 new species of *Hippocratea* (Celastraceae).

GLEASON[13] has published his tenth contribution to the flora of northern South America. It includes 15 new species in 12 genera.

RYDBERG[14] has described three new species from the Blue Ridge region, in the following genera: *Hypericum*, *Kneiffia*, and *Stachys*.

SMALL[15] has described a new species of *Nyssa* from the pineland swamps of

[6] SMALL, JOHN K., A new pinweed from southern peninsular Florida. Torreya **27**:102, 103. 1927.

[7] ———, A new *Chamaesyce* from tropical Florida. Torreya **27**:104. 1927.

[8] LEWTON, F. L., *Shantzia*, a new genus of African shrubs related to *Gossypium*. Jour. Wash. Acad. Sci. **18**:10–16. 1928.

[9] HONDA, M., Revisio Graminum Japoniae. XIV. Bot. Mag. **41**:635–641. 1927.

[10] LEONARD, E. C., *Ruellia tuberosa* and a few of its close relatives. Jour. Wash. Acad. Sci. **17**:509–520. 1927.

[11] STANDLEY, P. C., New plants from Central America. Jour. Wash. Acad. Sci. **17**:520–528. 1927.

[12] GOSSWEILER, JOHN, Plants from Angola and Portuguese Congo. Jour. Bot. Suppl. **65**:73–80. 1927.

[13] GLEASON, H. A., Studies on the flora of northern South America. X. Bull. Torr. Bot. Club **54**:603–618. 1927.

[14] RYDBERG, P. A., New species from the Blue Ridge. Toreya **27**:84–90. 1927.

[15] SMALL, JOHN K., A new *Nyssa* from Florida. Torreya **27**:92–93. 1927.

Florida. The author says that the specific name *ursina* "refers to the fact that the bears eat large quantities of the fruit in the fall and winter seasons." SMALL[16] has also described a new species of *Chamaesyce* which belongs to the endemic flora of the Everglade Keys.

COCKERELL[17] has described a new oak, *Quercus utensis*, from the Eocene deposits in the Roan Mountains of Colorado.

In continuation of the contributions to the Flora of Siam by the Royal Botanic Gardens, Kew,[18] 26 new species are described, all but two of them being Leguminosae. The new genera are *Afgekia* (Galegeae) and *Nimiria* (Mimoseae).

NAKAI[19] has published the sixteenth part of the woody flora of Korea, describing the Araliaceae and Cornaceae. The text is in both Japanese and English, and is a very detailed presentation of the classification. The collection of plates is especially noteworthy, showing in detail the structures of all the species. The Araliaceae include 12 species, in 7 genera, 3 of the species being new. The Cornaceae include 8 species in 5 genera, a new tribe (Aucubeae) being established.

COKER[20] has described 17 noteworthy species of Basidiomycetes from North Carolina, in 12 genera, illustrated by 11 plates. Five of the species are new, belonging to the genera *Cyphella, Craterellus*, and *Amanita*.—J. M. C.

Anatomy of variegated leaves.—The nineteenth contribution to LINSBAUER'S *Handbuch der Pflanzenanatomie* is a discussion by KÜSTER of the anatomy of the variegated leaf. Although KÜSTER[21] urges the desirability of restricting the term variegated to those types of leaves in which the border between green and lighter areas is sharply marked, he devotes Part I of his treatise to a discussion of chlorosis, mosaic diseases, etc. (variegations in which the border is not sharply marked). In this part he considers the following topics: Form, position, and vertical distribution of light and green areas; histology; cytology; physiology; and etiology. The author takes the position that transmissible variegations (chloroses) are not the result of the action of pathogenic organisms, and that all attempts to invoke these as causes are based upon faulty observations and improbable assumptions.

[16] ———, A new *Chamaesyce* from Florida. Torreya **27**:93–94. 1927.

[17] COCKERELL, T. D. A., A new oak from the Green River Eocene. Torreya **27**:94–95. 1927.

[18] Contributions to the Flora of Siam. XXIII. Kew Bull. no. 9. pp. 374–395. 1927.

[19] NAKAI, T., Flora Sylvatica Koreana. XVI. Araliaceae and Cornaceae. Forestal Exp. Sta. Keijo, Japan. pp. 92. *pls. 29.* 1927.

[20] COKER, W. C., New or noteworthy Basidiomycetes. Jour. Elisha Mitchell Sci. Soc. **43**:129–145. *pls. 12–22.* 1927.

[21] E. KÜSTER, Anatomie des panaschierten Blattes. Handbuch der Pflanzenanatomie, edited by K. Linsbauer. **8**:1–68. *figs. 54.* Berlin: Gebrüder Borntraeger.

Part II, which comprises the larger part of the volume, is devoted to variegations with sharply defined areas. In addition to the topics discussed in Part I, the second part includes a discussion of distribution of variegations on the leaf blade and on the shoot, and developmental aspects and biology. An appendix is devoted to anthocyanin variegations. This excellent volume is concluded with a literature list of 162 titles, in which the American literature is included.—G. K. K. LINK.

Chemical nature of enzymes.—A problem of very great interest and importance in biology, and one which has long resisted solution, is the chemical nature of enzymes. Enzymes have been regarded by some as carbohydrate in nature, and by some as protein. Most of the recent work has supported the latter view. It has been suggested that a particular group in a complex molecule is responsible for enzyme activity, and FALK has made the suggestion that different groups in a complex molecule may be responsible for various enzyme activities.

SUMNER[22] seems to have shown definitely that the enzyme urease,[23] of *Canavalia ensiformis*, is a protein of the globulin group. He has obtained the protein in the form of octahedral crystals, which the microscope shows are practically uncontaminated with foreign material. They showed much greater urease activity than the purest urease preparations previously obtained by the author without crystallization. In order to get a solution of urease it was necessary to dissolve the crystals; if solvents were used, which did not dissolve the crystals, the solutions obtained showed little or no urease action. Chemical tests showed that the crystals were purely protein, and previous work on urease has shown that it behaved as a protein when treated with various reagents. Tests showed that the crystals were nearly free of ash, and this too agreed with previous work on preparations of the enzyme.

It will be interesting to see whether the urease of other plants is the same as that of the jack bean, and also whether other enzymes can definitely be shown to be protein in nature. SUMNER'S work should stimulate much further investigation along this line.—S. V. EATON.

Fossil conifers of western America.—MASON[24] has given an interesting account of the fossil record of conifers in the Pacific Coast region. The coniferous forest of the Pacific Coast is of great interest, on account of its endemic features. The species described, when considered in connection with the existing coniferous flora, seem to justify the conclusion that the presence of the endemic elements in the California region are relicts from floras that were widespread over much of the western part of North America.—J. M. C.

[22] SUMNER, J. B., The isolation and crystallization of the enzyme urease. Jour. Biol. Chem. **69**:435–441. 1926.

[23] ———, The recrystallization of urease. Jour. Biol. Chem. **70**:97, 98. 1926.

[24] MASON, H. L., Fossil records of some West American conifers. Publ. 346, Carnegie Inst. Wash. pp. 139–158. *pls. 1–5*. 1927.

Cambridge University Press

The Structure and Development of the Fungi. By H. C. I. GWYNNE-VAUGHAN, D.B.E., and B. BARNES, B.Sc. With a frontispiece and 285 text-figures. Demy 8vo. $4.25.

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